DEVELOPMENT AND STANDARDIZATION OF A MENTAL ABILITY TEST FOR SCHOOL CHILDERN (12 – 17 YEARS)

BY

SOUMI AWASTHY

A THESIS

SUBMITTED TO BUNDELKHAND UNIVERSITY

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY IN PSYCHOLOGY

2005

CERTIFICATES

Narender K. Chadha
Professor of Psychology,
Department of Psychology,
Arts Faculty,
University of Delhi,
Delhi, **INDIA**

This is to certify that the thesis entitled 'Development and Standardization of a Mental Ability Test for School Children (12-17 years)' by Mrs. Soumi Awasthy has been conducted under my direct supervision and guidance. To the best of my knowledge, this is an original piece of work and is within the area of her registered topic. In neither full nor any part of this thesis has been submitted to any other university or to an institution for award of any degree or diploma.

Date : 28/3/2005

(N.K Chadha)
Professor of Psychology

i

DECLARATION CERTIFICATE

I declare that the thesis entitled 'Development and Standardization of a Mental Ability Test for School Children (12-17 years)' submitted by me for award of Ph.D Degree is an original work and it has neither been submitted in full nor in part to any other university or Institution for award of any degree or diploma.

Dated : 02 Nov '05

(SOUMI AWASTHY)

ABSTRACT

ABSTRACT

Mental Ability and its measurement is very fascinating in psychological research. In fact, it is the most popular concept in the field of psychology. Mental ability or intelligence has been defined in many ways by many psychologists as : innate, general cognitive ability, ability to carry on abstract thinking, ability to understand complex ideas, to adapt effectively to the environment, to learn from experience to engage in various forms of reasoning, and so on. Thus, tests are being developed to measure a variety of cognitive skills such as reasoning, abstract thinking, problem solving which experts consider crucial aspects of mental ability.

An endeavour has been made in this research study to develop and standardize a mental ability test for children (12-17 years of age). For the purpose of this research, mental ability has been defined as the basic reasoning ability of an individual which he or she applies in problem solving of many kinds. The aim of this research work was to develop a test of mental ability for school children (12-17 years of age) of Indian origin which include both verbal and non-verbal stimuli. The sample consisted of 600 school boys of which 200 boys were used for the actual try-out of the verbal and nonverbal mental ability tests, 200 were used for establishing the reliability index, 100 were used for establishing the validity index

and another 100 boys were used for the establishment of norms which was done for the age group of 15-17 years.

The study was conducted in two phases. Phase I consisted of development of a test of mental ability. Components to be included for the measurement of mental ability was determined in this phase. The following types of items were developed for the measurement of mental ability, namely, analogies (both verbal and non-verbal), classification or odd-man-out (both verbal and non-verbal), series or sequences (both verbal and non-verbal), numerical ability (only verbal), spatial ability (only non-verbal), perceptual speed and accuracy (only non-verbal), matrices (only non-verbal), deductive reasoning (only verbal), coding (only verbal) and verbal comprehension (only verbal). An initial item bank of 250 items both verbal and non-verbal were prepared which were scrutinized by a panel of judges on certain parameters. Based on their suggestions 200 items were retained for the try-out of which 100 were verbal items and the other 100 were non-verbal items. Pre-tryout of the item bank was done on a representative population to check the tests for shortcomings which could be further improved. The actual tryout was conducted on 200 school boys. Item analysis was done and all those items which fell within the difficulty range of .30 to .70 and discrimination index of .20 and beyond were retained. Based on the item analysis 40 items were retained for the verbal ability test and another 40 were retained for the non-verbal test. These items were then arranged in graded difficulty level and the most easy item was the first item of the test while the most difficult item was the last one in the test. The Phase II consisted of fixing the optimum

time limit of the tests and establishing the reliability and validity indices of both the verbal and non-verbal tests. Norms for the age group 15-17 years was also prepared in this phase. The final verbal and non-verbal tests were administered on 200 school children to fix the optimum time limit for both the tests. Based on statistical parameters 20 minutes was fixed as the optimum time limit for both the verbal and non-verbal tests. Kuder-Richardson formula 20 was used for establishing the reliability of the tests. The reliability index for verbal mental ability test was .84 and .85 for the non-verbal mental ability test. Responses of 100 school boys on Raven's Standard Progressive Matrices (SPM) were used as the validity criterion. The academic performance of this sample in the previous annual school examination was also taken as a criterion. The validity indices of the verbal mental ability test was .61 and .73 for the non-verbal test with SPM as the criterion while it was .47 and .35 for the verbal and non-verbal tests respectively with academic performance as the criterion. The validity indices were therefore highly significant with SPM as the validity criterion. For the development of norms both the verbal and non-verbal mental ability tests were administered on 100 school children of the age group of 15-17 years. The mean and standard deviations for both the verbal and non-verbal tests were computed. Norms were prepared by converting the raw scores of both the tests to standard scores (equivalent or converted scores). A mean of 50 and standard deviation of 10 were used for converting the raw scores for both the tests. The summed equivalent scores were divided into five point norms, namely, well above average intelligence, above average intelligence, average intelligence, below average intelligence and well below average intelligence.

Two mental ability tests, namely, a verbal and non-verbal test were developed in this study. The tests were standardized on psychometric principles on school children (boys) of 12-17 years of age. The reliability and validity indices of both the tests were found to be highly significant. Norms were prepared for the age group of 15-17 years.

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

I express my sincere gratitude to Prof. N.K Chadha, Department of Psychology, University of Delhi, Delhi for his constant encouragement, guidance and supervision during the course of this research work.

I am grateful to all the students of the schools who relentlessly filled up the test booklets and gave the invaluable data on which this research work is based. Without their sincere effort it would not have been possible to complete this research work. Thanks are due to the Principals and teachers who made the collection of data possible from their schools.

I will be failing in my duties, if I do not acknowledge my gratitude to my husband, who has been a constant source of inspiration from inception to completion of this work and has extended his moral support throughout this momentous period. Without his constant encouragement to complete this research work it would not have been possible to devote both dedicated time and devotion to do so.

I wish to also thank my mother and my son, Sidhant who ungrudgingly let me use his play time and computer during the course of this research work.

I also take this opportunity to thank my colleagues in my office (DIPR) who have encouraged and supported me in this endeavour.

Finally, I gratefully acknowledge my indebtedness and gratitude to all of them who have contributed directly or indirectly to the completion of this research work.

Dated: 02 Mar '05

SOUMI AWASTHY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

LIST OF APPENDICES

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

Individuals differ from one another in both physical and psychological characteristics. Each man is unique. Men differ from one another in their colour, height, weight, size, strength, and even in their mode of social interaction. Varied are also their mental abilities and behaviour, that is, some men are found to be very alert, witty, sensitive, and quick to react, whereas others are average and even found to be dull. There are outgoing extroverts as well as quiet, shy, withdrawn and very passive individuals. Many are social and friendly, where as others are exclusively self-centered and inhibited. In a classroom set up, a teacher comes across very bright, intelligent and creative students as well as students who are just average or dull or even very dull. All these are reflections of their differences in mental abilities. The term intelligence is synonymous with several other concepts such as talent, brilliance, sharpness, clear-sightedness, smartness, reasoning, judiciousness, rationality, adeptness and prodigy. For this research work the terms "intelligence" and "mental ability" have been used interchangeably.

Intelligence has been explained in various ways. It is conceived as a complex universal ability to understand the world, to profit from past experiences and training, to imagine various possibilities, to surmount difficulties, to protect oneself when life is physically and psychologically endangered, to be engaged in abstract and innovative thinking using concepts, symbols, and logical reasoning. Intelligence is an abstract concept. Individual's intelligence is expressed through his intellectual activities, which can be measured formally and informally. Informal assessment of one's intellectual activities can be made through some acts, such as simple puzzle solution, filling up a gap, answering correctly short but problem questions, simple numerical abilities, explaining a concept and adaptation to a novel situation.

The Western concept of intelligence originates with the Greeks. Plato described the three aspects of the soul as intellectual, emotional, and moral; later these were referred to as cognition, affection, and conation (Das, 2004). But again, what precisely is intelligence? The term 'intelligence' is derived from two Latin words: *intellegentsia* and *ingenium*. The former as used by Cicero means something like 'understanding' and 'knowledge'; the latter means 'mental disposition' or 'ability'. Fundamental to intelligent behaviour is an underlying disposition that enables us to reason, to think abstractly and to learn. The greater the ability, the more we are likely to learn and to know. This knowledge in itself is a sign of high intelligence though in a sense derivative (Eysenck, 1998).

The concept of intelligence has been there from time immemorial and has also been mentioned in the Vedas. In Vedas, intelligence is know as *"Buddhi."* Due to its immense

importance in leading a person towards success the conception of it does matter to each and every individual. In our Indian culture, the term intelligence has been conceived and expressed in various terms such as *'buddhi', 'manisha', 'dhi', 'mati', 'sambit', 'medha', 'chetna', 'chaitanya', 'upalabdhi', 'pronidhan', 'prekhya', 'jnapti', and 'prajna'.* These terms denote various mental functions associated with the manifold demonstrations of intelligent understanding and behaviour.

Intelligence is one concept which is easier to recognize than to define. In one survey made by Robert J. Sternberg (1981), a group of people were asked to define what they meant by intelligence. Their responses indicated three major components of intelligence which later came to be known as the western concept of intelligence.

Western Concept Of Intelligence

The western psychologists specifically Sternberg R. J.(1981,1985c) have a different out look to the notion of intelligence. He specified three factors of intelligence, firstly, practical problem solving ability, that is, people who can reason logically, identify connections among ideas and see all aspects of a problem. Second, was the verbal ability which included behaviours like speaking clearly and articulately, having verbal fluency and conversing well and, finally, was the social competence, that is, the ability to accept others for what they are, admitting mistakes and displaying interest in the world at large. Sternberg through this extensive studies found that the older individuals tend to view every day competence as more important in characterizing the differences between individuals of average and

3

exceptional intelligence than do younger individuals. The middle aged and older individuals tend to combine crystallized intelligence with problem solving abilities for most age specific prototypes.

Siegler & Richards (1982) through research reported 5 traits that characterize intelligence at different ages. At 6 months old, these traits were recognition of people and objects, motor coordination, alertness, awareness of the environment and verbalization. At 2 years of age, they were verbal ability, learning ability, awareness of people and environment, motor coordination and curiosity. At 10 years of age, they were verbal ability, followed by learning ability, problem solving ability, reasoning ability and creativity. At the adult level the traits were reasoning ability, verbal ability, problem solving ability, learning ability and creativity. There is, thus, a trend toward conceiving of intelligence as less perceptual-motor and as more cognitive with increasing age.

Yussen & Kane (1985) revealed that the older children's conceptions were more differentiated than were those of younger children and that with advancing age children increasingly characterized intelligence as an internalized quality. But older children were less likely than younger children to think that overt signs indicate intelligence.

Eastern Concept Of Intelligence

Intelligence is perceived differently in different cultures. Yang & Sternberg (1997a) have reviewed the Chinese philosophical conceptions of intelligence. The Confucian

perspective emphasizes the characteristic of benevolence and of doing what is right. Where as, the Taoist tradition, emphasizes the importance of humility, freedom from conventional standards of judgment, and full knowledge of one self and of external conditions. Yang & Sternberg (1997b) studied the contemporary Taiwanese conceptions of intelligence and found five factors underlying these conceptions which can also be called the eastern concept of intelligence:

(a) A general cognitive factor, much like the general factor in conventional western tests of intelligence,

(b) Interpersonal intelligence,

(c) Intra personal intelligence,

(d) Intellectual self-assertion and,

(e) Intellectual self–effacement.

The eastern concept conceives memory to be an important aspect of intelligence but the western concept conceive it as of trivial importance. Das (1994) after reviewing the eastern notions of intelligence, has suggested that in Buddhist and Hindu philosophies, intelligence not only involves, waking up, noticing, recognizing, understanding and comprehending but also includes such things as determination, mental effort and even feelings and opinions in addition to more intellectual element. Older children also are less global in the qualities they associate with intelligence than are younger children. There is a tendency as well for younger children to think of intelligence largely in terms of social skills but for older children to think of intelligence largely in relation to academic skills.

Cultural Context Of Intelligence

Since the beginning of recorded history, identification and nurturance of intellective competencies and skills have fascinated people in different cultures. The considerations of intelligence as a cultural genre demand a move towards the context dependent, cultural and processual approach to intelligence (Srivastava & Misra, 2001). As Buttterworth (1994) has argued, understanding of intelligence requires referring to the internal organization of knowledge, external or contextual factors, and the behavioural expressions of intelligence. Successful adaptation to one's own cultural niche makes one intelligent (Scheibel, 1996). Therefore, intelligence cannot be tested independently of the culture that gives rise to the test (Cole & Cole, 1993).

The empirical studies of people's notion of intelligence, document that in many western societies there was an extreme emphasis on the development of technological intelligence, for example, attention, observation, speed of learning, school intelligence and manual dexterity (Mundy-Castle, 1974). In the western world, behaviours leading to control over the physical environment were highly valued (White,1959). In contrast, in many of the South Asian, African and Latin American cultures, a marked 'social' or relational orientation was prevalent in which harmony with nature and coexistence were emphasized. It has been reported that intelligent people are more conforming and slow in Africa (Wober, 1974). They emphasized capability in specific situations and social responsibility, such as

6

cooperativeness and obedience (Serpell, 1982). In Kenya, parents consider intelligence as the ability to do what is needed to be done around the homestead without being asked (Harkness, et al, 1992). The Japanese notion of intelligence emphasizes social competence, task efficiency, originality and reading and writing (Azuma & Kashiwagi, 1987). In China, intelligence is seen as constituted of three factors, namely, non-verbal reasoning ability, verbal reasoning ability and rote memory (Chen, 1994).

The Indian tradition emphasizes a socially constituted/embedded and a relational concept of the person with a context-sensitive design of human action. It views the individual as a social being with the shared and relational notion of control. It also simultaneously subscribes to the temporal and atemporal existence of a human being (Misra & Gergen, 1993). Analysis of Sanskrit *suktis* and proverbs in Hindi indicated four broad aspects of intelligence, that is, cognitive competence, social competence, competence in action and emotional competence. The Indian notion, thus, stands at a distance from the prevailing western view. In the Indian view a person is judged intelligent if he or she is competent in social problem-solving and is generally pro-social in orientation. Intelligence is not confined to the success of the individual alone, rather it aims at achieving the common good (Srivastava & Misra, 2001).

Dweck (1999) has also investigated concepts of intelligence among children and found that children generally have one of the two kinds of concepts regarding the plasticity of intelligence. Entity theorists believe that intelligence is "innate". However, the incremental

theorists believe that it is learned one. Differences of cultures in conceptions of intelligence have been recognized now for sometime.

Gill & Keats (1980) revealed that the western school value academic skill whereas the eastern school value practical skills as well as speech and creativity. The eastern school emphasizes social and cognitive attributes in their conceptions of intelligence (Dasen,1984).

Western school of thought emphasizes on generalization or going beyond the information given, speed, minimal moves to a solution and creative thinking. More over, silence is interpreted as a lack of knowledge. Whereas, in the eastern school, for example, the Wolof tribe in Africa (eastern) views people of higher social class and distinction as speaking less.

There were again differences in the conception of intelligence among blacks and whites. The black group emphasizes the non-verbal communication skills more than the white groups who put more emphasis on verbal communication skills.

DEFINITIONS OF INTELLIGENCE

Intelligence has been defined in several ways. Probably, the most famous study of experts' definitions of intelligence was done by the editors of the '*Journal of Educational*

Psychology' (Intelligence and its Measurement, 1921). Contributors to this issue provided the following definitions of intelligence:

1. The power of good responses from the point of view of truth or facts
    (E.L.Thorndike);

2. The ability to carry on abstract thinking (L.M. Terman);

3. Sensory capacity, capacity for perceptual recognition, quickness, range or flexibility of association, facility and imagination, span of attention, quickness or alertness in response (F.N. Freeman);

4. Ability to learn or having learned to adjust oneself to the environment (S.S. Colvin);

5. Ability to adapt oneself adequately to relatively new situations in life (R. Pintner);

6. The capacity for knowledge and knowledge possessed (B.A.C. Henmon);

7. A biological mechanism by which the effects of a complexity of stimuli are brought together and given a somewhat unified effect in behaviour (J. Peterson);

8. The capacity to inhibit an instinctive adjustment, the capacity to redefine the inhibited instinctive adjustment in the light of imaginally experienced trial and error, and the capacity to realize the modified instinctive adjustment in overt behaviour to the advantage of the individual as a social animal (L.L. Thurstone)

9. The capacity to acquire capacity (H. Woodrow);

10. The capacity to learn or profit by experience (W.F. Dearborn); and

11. Sensation, perception, association, memory, imagination, discrimination, judgment, and reasoning (N.E. Haggerty).

To the extent that there are common themes in these definitions, they would appear to be with respect to the ability to adapt to the environment and the ability to learn.

Another symposium designed to update the earlier one of 1921 was held 65 years later in 1986. Two dozen experts were asked to define intelligence (Sternberg & Detterman, 1986). The main similarities and differences between the two symposia are as follows (Sternberg & Berg,1986):

First, general agreement existed regarding the nature of intelligence. The attributes such as adaptation to the environment, basic mental processes and higher order thinking were prominent in both the symposia.

Second, the issue of one versus the many, that is, Is Intelligence one thing or is it manifold ? continued to be of concern for both the symposia.

Third, despite similarities in views over the 65 years, some salient differences in the two listings were also found. Metacognition- conceived of as both knowledge about and control of cognition-played a prominent role in the 1986 symposium but virtually no role in the 1921 symposium. The salience of metacognition and executive processes can be attributed to the rise of the computational metaphor in the current study of intelligence. In the later symposium, a greater emphasis also was placed on the role of knowledge and the interaction between knowledge and mental processes. They also showed considerable emphasis on the role of context, and particularly of culture, in defining intelligence, which was not present in the 1921 symposium.

Nevertheless, some of the definitions of intelligence given below provides the following important characteristics of intelligence. First, intelligence is a cognitive process involving rational and abstract thinking. Second, it is goal directed and purposeful, which means that all intelligent activities are planned to reach a self-determined goal. Finally, it involves social competence to help individuals adjust to their environmental surroundings.

1. Intelligence is the innate general cognitive capacity (Francis Galton, 1883).

2. Intelligence is the ability to think abstractly (Lewis Terman, 1921).

3. Intelligence is what the intelligence tests test (E.G. Boring, 1923).

4. Intelligence is a particular instance of biological adaptation (Jean Piaget, 1952)

5. Intelligence is a person's capacity for goal-directed adaptive behavior (Robert Sternberg & William Salter, 1982).

6. Intelligence is the global and aggregate capacity of the individual to think rationally, to act purposefully, and to deal effectively with the environment (David Wechsler, 1975).

7.   Intelligence is the ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by careful thought (Neisser, et al, 1996).

8.   Intelligence can also be defined as a group of complex mental processes as sensation, perception, association, memory, imagination, discrimination, judgment and reasoning (Cattell, 1971; Guilford, 1967; Gardner, 1983, 1993; Sternberg, 1997).

THEORIES OF INTELLIGENCE

Broadly speaking, theories of intelligence may be categorized under three approaches, eg., the structure theory of factor-analytic/psychometric approach, the information-processing/cognitive approach and the biological approach. However, we may also categorize them under two approaches only, eg., the classical approach and the contemporary approach.

Within the classical approach the following theories are discussed:

(i)   Two-factor theory of Charles Spearman (1927);

(ii)   Theory of Primary Mental Abilities by Louis Thurstone (1938);

12

(iii)   'gf' and 'gc' theory of Raymond B. Cattell (1971);

(iv)   Theory of two levels of intelligence by Arthur Jensen (1969);

(v)   Structure-of-Intellect Model by J.P. Guilford (1967).

Among the contemporary approaches the following theories are discussed:

(i)   Theory of Multiple Intelligences by Howard Gardner (1983);

(ii)   Triarchic theory of intelligence by Robert J. Sternberg (1985a);

(iii)   PASS model of intelligence by J.P.Das (1994).

Charles Spearman (1927) proposed a **"Two Factor Theory"** of intelligence. It was a theory of trait organization based on the statistical analysis of test scores. The empirical components of Spearman's research were derivative, that is, they were based on an attempt to measure individual differences in sensory-discrimination capacities and to relate performance on these measures to measures of academic performance and to ratings of intellectual capacity for samples of school children.

Spearman (1904a) obtained correlations among several measures of sensory-discrimination ability. He related sensory discrimination ability measures to measures of academic achievement. Spearman obtained aggregate indices of discrimination ability and aggregate indices of intellectual ability as determined by academic performance. The disattenuated correlation between the two led him to conclude " that the common and

13

essential element in the intelligences coincides with the common and essential element in the sensory functions".

Spearman developed a theory to account for the correlations in the matrix he had obtained. He assumed that there must be a common intellectual ability that accounted for the positive manifold of correlations. He labeled this 'g' for general intelligence. He assumed that the variance on a particular measure could be partitioned into a component attributable to 'g' and to a second specific source of variance 's'. Spearman pointed out that all intellectual activities have a single common factor called the general factor or "g" factor- also known as the 'mental energy'. Again he proposed a number of specific or 's' factors. Each of the 's' factors refers to a specific single activity. He explored statistically the interrelations among scores obtained by many persons on various tests. Positive correlation between any two mental functions was attributed to 'g' factor. But the specific factors have low correlations among them. Spearman's model implies that the objectives of psychological testing should be to measure the amount of each individual's 'g'. The 'g' factor runs through all abilities, and forms the basis for prediction of the individual's performance. This 'two –factor theory' of intelligence has a number of consequences. If the specificities associated with each measure are independent, and if 's' is uncorrelated with 'g', then the correlation between any two measures of intelligence is attributable to the extent to which they share 'g'. Measures that have a high g-to-s ratio will tend to correlate with each other score substantially than measures that have low g-to-s ratios. Thus, measures of intelligence may be arrayed in a hierarchy in terms of their g-loadings.

Louis Thurstone (1938) advanced the **Theory of Primary Mental Abilities' (PMA)**, which states that intelligence consists of seven major functions, each of which is relatively independent of the others. These factors are: verbal comprehension, numerical abilities, spatial relations, perceptual speed, word fluency, memory and inductive learning. He analyzed the inter correlations of a set of 56 mental tests, and identified the seven factors listed above. He also believed that there is no single score of an aggregate intelligence.

Raymond B Cattell (1971) suggested that general intelligence could be broken down into two relatively independent components called **fluid intelligence (gf)**, denoting reasoning, memory and information-processing capabilities and **crystallized intelligence (gc)**. 'gf' was the ability to see complex relationships and solve problems and it was measured by the tests of block design and spatial visualization. On the other hand, 'gc' referred to the knowledge that the person had already acquired and the ability to access that knowledge which could be measured by tests of vocabulary, arithmetic and general information. Fluid ability was viewed as a biologically influenced dimension of 'g' that declined over the adult life span, whereas the crystallized intelligence was believed to be influenced by education and cultural exposures and was not assumed to decline over the adult life span. Cattell's theory was supported by second–order factor analysis that incorporated the first order Thurstone ability factors. Modifications in the theory resulted in the specification of five-second-order factors. They were-gf, gc, memory, visualization and speed factors.

The gf-gc theory can be thought of as a two-stratum model. The gf and gc factors represent the highest level of cognitive function or inference. The gf factor includes the activities to perceive relationships among stimulus pattern, to comprehend implications and to draw inferences from relationships. It is dependent on the efficient functioning of the central nervous system. Standardized test measure this type of intelligence through analogies, series completions and other tasks involving abstract reasoning. The gc factor which is dependent on experience and education within a culture, consists of a set of skills and knowledge that individuals acquire throughout their life spans. It includes the first order abilities of verbal comprehension, evaluation, of semantic relationships and cognition of semantic relationships. Standardized test measure 'gc' through vocabulary, general knowledge and verbal comprehension question.

The gf-gc theory explains and predicts intellectual development across the life span (Horn, 1994, Horn & Donoldson, 1976). Infants ability center around the lowest level of hierarchy. As children develop, they become better able to perform tasks that are representative of the higher levels of functions. The most comprehensive analysis of the structure of ability factors is found in **Carroll's three stratum theory** (1993). He reanalyzed the ability matrices and developed a three-stratum taxonomic structure in which the structure of intelligence is reflected as a pyramid. The top of the pyramid, **stratum III,** is the conceptual equivalent of Spearman's 'g'. The middle of the pyramid **stratum II,** consists of eight factors that are differentially influenced by 'g'. The base of the pyramid, **stratum I,** consists of numerous specific abilities such as quantitative reasoning and lexical knowledge each ability of stratum I is related to one or more of the eight abilities that

16

compose stratum-II. Most current psychometric models propose a hierarchical structure to intelligence.   This type of structure places one or more general factors at the top of the hierarchy and delegates specific factors to lower levels.   In other words, the higher a factor is on a hierarchical model, the farther, removed it is from people's actual performance on psychometric tests.

The '**Structure-of-Intellect**' model was proposed by J.P.Guilford (1967) on the basis of more than two decades of factor-analytic research. He tried to make logical explanations of the factors involved in mental functions. Guilford's model of intelligence was not hierarchical.   Guilford began with a descriptive analysis of test that could be used to measure intelligence. He developed a three-dimensional taxonomy that permitted him to classify any test with respect to its position on the dimensions of **content** or type of information, the **product** or the form in which the information is represented and the **operation,** or type of mental activity performed.   He distinguished five operations: cognition, memory, divergent production, convergent production and evaluation.   Each of these operations could be applied to one of five types of contents: visual, figural, symbolic, semantic and behavioral. The application of these processes to these contents could result in one of six products: units, classes, relations, systems, transformations and implications. Each task performed by an individual can be identified according to a particular type of content, product and operation involved. There are, therefore, 150 independent abilities in the model defined by all possible combinations of position on each of the three facets of the model.   For example, a test of vocabulary assesses one's ability for cognition of units with semantic content, while learning a form of dance requires memory for behavioural contents.

In Guilford's model, the convergent and divergent thinking are considered to be centrally involved in creativity and intelligence. On addition to other operations, creative abilities involve divergent operations. On the contrary, in convergent thinking, the production of single correct response is related to estimate intelligence.

Jensen in 1969 proposed a **'Two level theory'** of mental abilities, which sparked a debate on the association of heredity versus environment with intelligence. He demonstrated clear-cut genetic differences in the average intelligence of races and social classes. Jensen suggested that two genetically based level of intelligence existed. The level-1 ability is **associative learning**, which consists of short term memory (STM), rote learning, attention, and simple associative skills. The level II is called **cognitive learning**, which consists of abstract thinking, symbolic thought, conceptual learning, and the use of language in problem solving. He argued that Level I ability, i.e., associative learning which is concentrated more on learning is equally distributed across all racial and national groups, but on the contrary, Level II, i.e., cognitive learning is concentrated more in the middle class Anglo-American populations than in the lower class black populations. According to him, genetic differences in intelligence existed among people coming from different races, nationalities, and social classes.

The classical notion of intelligence, which defined it in terms of a single index of cognitive abilities, has undergone major changes. It is now believed that intelligence is not one or

unitary ability, rather there are many intelligences which people display while solving problems in everyday life.

Howard Gardner rejected the conception of intelligence as a unitary ability and proposed the **theory of multiple intelligences (MI)**. Gardner's theory of multiple intelligences focuses more on domains of intelligence and less on mental processes. It is based on three principles. First, intelligence is not a single entity; rather there exists multiple intelligences, each distinct from others. Second, these intelligences are independent of each other. In other words, if a person is good in one type of intelligence, it does not give any indication about how good or bad the person may be on other types of intelligences. Third, different types of intelligences interact. That is, different intelligences work together to provide a solution to a problem. According to MI theory (Gardner, 1983, 1998), there are at least eight independent and equally important types of intelligence that have evolved in the human species and are valued in a wide range of cultures. The eight intelligences are linguistic, logical-mathematical, spatial, musical, bodily-kinesthetic, interpersonal, intrapersonal and naturalistic. An intelligence is defined as "the ability to solve problems, or to create products, that are valued within one or more cultural settings" (Gardner,1993).

Although Gardner believed that the intelligence are relatively independent from each other, he acknowledged that they can work together within a domain. Intelligences are best measured in the contexts in which they naturally occur and concluded that paper-and-pencil tests are inadequate assessments (Chen & Gardner, 1997; Gardner, 1992).

The most recent contribution to understanding of intelligence comes from the work of cognitive psychologists. The cognitive psychologists apply information-processing approach to understand many aspects of human behaviour including intelligence. They believe that the way people receive information, store them in memory, and use strategies to solve problems provides a more accurate measure of intelligence. Thus, cognitive psychologists do not focus on the structure of intelligence, but on the processes underlying intelligent behaviour. In other words, they examine processes involved in an intelligent activity. The theories of Robert J. Sternberg and J.P.Das are two information-processing approaches under contemporary theories of intelligence.

Robert Sternberg (1982) of the Yale University, USA is one of the most prominent among the new generation of cognitive psychologists. Sternberg (1982) asked people to identify the characteristics of an intelligent person. The most frequently given responses indicated the following: (a) one who reasons logically and well; (b) one who reads widely; (c) one who keeps an open mind; and (d) one who reads with high comprehension. On the basis of his observation, and experimental research, Sternberg (1985a) formulated the **triarchic theory** of intelligence.

He theorized that intelligent behavior consists of three major components. Each component is a basic unit of information processing. According to him, such components consist of activities to acquire or store information, to develop problem-solving strategies, and monitor one's progress. The three basic and major components of intelligence are: (1) **Componential** intelligence (analysis of information to solve problem); (2) **Experiential**

intelligence (using prior knowledge and information in problem solving and creating new ideas); and (3) **Contextual** intelligence (using intelligence to adapt to environmental demands: practical intelligence).

The **PASS Model** of cognitive processing approach by Das, Naglieri and Kirby (1994) is an extension of information-processing approach. The PASS model of cognitive processing known as Planning, Attention, Simultaneous and Successive processing is based on Luria's analyses (Luria, 1973, 1980) of human brain structures and cognitive psychological research (Broadbent, 1958, Simon, 1976). Das, Naglieri and Kirby (1994) proposed the PASS cognitive processing model as a modern theory of intelligence. According to Das, intelligence is information processing that is dynamic in nature. It is not a static structure like ability.

Human cognitive processes involve three functional systems or units that work in harmony. The participation of all the three functional units is "necessary for any type of mental activity " (Luria 1973). The PASS model of intelligence has a strong neurological foundation. At the same time, it focuses on the cognitive processing components rather than their specific neurological locations. The PASS model advocates that intelligence is the result of an interdependent functioning of three neurological systems those responsible for arousal (and attention), coding (or processing), and planning. The two coding processes are simultaneous and successive. We receive information through our sensory organs such as eyes, ears, nose, skin, tongue, and internal organs. When the information is analyzed, the central processing becomes active. The four components of the central processing

21

mechanisms are: Planning (P), Attention (A), Simultaneous processing (S), and Successive Processing (S). All these four PASS processes operate on the existing knowledge base, which is the result of past learning, emotions, and motivations. In other words, the four processes become active within the context of an individual's knowledge base.

CHAPTER 2

HISTORY OF INTELLIGENCE TESTING

HISTORY OF INTELLIGENCE TESTING

Psychology, as a behavioural science, aims at studying behaviour scientifically, and tests are systematic procedures for comparing the behaviour of two or more persons. This accounts for the extensive use of psychological assessment and analysis of individual differences in general intelligence, specific aptitudes, educational achievement, vocational fitness and non-intellectual traits.

The invention of psychological tests, then known as mental tests, is generally attributed to Fransis Galton (1882-1911). He was interested in studying individual differences and was the first scientist to adopt the concept that the errors of measurements in individuals could be cancelled out through the mass effect of large samples. However, through the archives, the history of psychological testing can be traced to the ancient Greeks and the Chinese who used the tests for administrative purposes.

During the last half of the nineteenth century, first Sir Francis Galton in England (1869,1883) and then Alfred Binet in France (Binet & Henri,1895) developed leading intelligence tests of the day. Sir Francis Galton could undoubtedly be crowned as the father of mental testing. He was the first to work on hereditary genius. He argued that a genius is a normally distributed and heritable characteristic of human. He studied individuals rather than groups. Galton established a laboratory in the South Kensington Museum of London in 1882 for the measurement of individual differences. For a small fee, visitors to the museum were given a battery of tests designed to measure auditory and visual sensory discrimination abilities as well as reaction times to stimuli and the ability to exert hand-squeeze pressure on a dynamometer. The previous held conception was the importance of knowledge derived from sensations as a foundation for complex cognitive functioning. But Galton believed that the sensory discriminative capacities of idiots were impaired. He believed that individuals with high intelligence would have keener discriminative capacities than individuals with low intelligence (Galton, 1883). He also stated that people differ in their ability to recall images and also in the devices they employ as aids to memory. Galton believed that people take in information through their senses, and thus the most intelligent people must have the best-developed senses. His test included a series of sensory, motor and reaction time tasks, all of which produced reliable, consistent results, but none of them proved to be valid as measures of the construct of intelligence (Cohen, Montague, Nathanson, & Swerdlik, 1988).

Galton's interest in the measurement of relatively simple cognitive functions as basics for understanding genius was the ancestor of an active area of research at the end of the 19th

24

century.   Cattell (1890) was the first to use the term Mental Tests and in his book on "Mental Tests and Measurement" described measures of 10 psychological functions, namely, muscular strength, speed of movement, sensitivity to pain, weight discrimination, reaction time, remote memory, etc. which according to him were instrumental for determining individuals intellectual development. Cattell's program of research was very much influenced by Galton.

Galton in his commentary wrote about Cattell's research work and also indicated that it would be useful to relate scores from the psychological measures to ratings of intellectual eminence.

While Galton and his other American contemporaries were struggling with the problem of inferring complex abilities from simple sensory motor tasks, a different theory and method was being developed by a group of European psychologists and leading this movement was Alfred Binet. He and his colleagues believed that differences in the ability to think and reason, to solve difficult problems and to make use of the experiences of the past in adapting to new conditions can best be measured by setting the subject solve problems that involve these very processes. So the sole challenge was of finding suitable tasks which could be fairly regarded as the samples of the kind of abstract judgment and reasoning demanded in those situations which could be handled by intelligent people only. In 1896, Binet and Henri published an article in which they described the measures of eleven mental faculties, namely, memory, mental imagery, imagination, attention, comprehension,

suggestibility, aesthetic appreciation, force of will as indicated by sustained muscular tasks, moral sentiments, motor skills and judgment of visual space.

Binet eager to separate mentally retarded from normal children in a classroom, published the first 'real' intelligence test in 1905. Binet declared that because intelligence is complex, so, too, must be its measurement. He conceptualized intelligence as one's ability to demonstrate memory, judgment, reasoning, and social comprehension, and he developed tasks to measure these aspects of global intelligence. Binet's contributions included his focus on language abilities (rather than non-verbal skills measured by Galton) and his introduction of the mental age concept derived from his use of age levels, ranging from 3 to 13 years, in his revised 1908 scale (mental age was the highest age at which the child had success; the intelligence quotient, or IQ, became the ratio of the child's mental age to chronological age multiplied by 100). The test resembled a modern test in four respects:-

(a) It was a test primarily of complex mental functions, including test of vocabulary and comprehension.

(b) The items attempted to assess different kinds of abilities.

(c) The test could be administered without special laboratory equipment.

(d) The items were grouped according to difficulty. Binet and Simon believed that children who were retarded generally performed at a level comparable to that of

normal children who were younger. Binet published two revisions of the test. The 1908 revision involved a shift to an emphasis on normal children and included specific age-graded equivalents for each item. The 1911 revision expanded the test using five items at each age, allowing for the calculation of a fractional age. Binet never converted mental age scores to IQ. Stern invented the IQ index.

$$IQ = \frac{Mental\ age}{Chronological\ age} \times 100$$

Lewis Terman of Stanford University translated and adapted the Binet-Simon scales in the United States to produce the Stanford-Binet and standardized the test on substantial numbers of children at different ages that lived in the United States. In 1960 Binet was revised without being restandardized (Terman & Merrill, 1960) and in the early 1970s, the Binet was restandardized without being revised (Terman & Merrill,1973).

A second great influence on the development of intelligence tests was the entry of America in the World War I in 1917. Large numbers of recruits needed to be tested quickly, leading to the development of a group IQ test, The Army Alpha by Arthur Otis. Immigrants who spoke English poorly or not at all had to be evaluated with nonverbal measures, spearheading the construction of the nonverbal group test, The Army Beta. The entire test development endeavour during World War I reflected a huge contribution by Robert

Yerkes. Binet's individually administered test was transformed into a time-saving group format; nonverbal tests (measuring problem solving) joined verbal tests as legitimate ways to infer a person's general ability; IQ tests were found to be useful for adults, not just children; IQ tests were found to be valuable for high functioning people, not just the lower extreme (they gained respect as valid tools for selecting officers and placing men in different types of service); data from huge samples were analyzed, demonstrating the IQ tests validity in discriminating officers from recruits (Cronbach, 1975; Kaufman, 1990a; Yoakum & Yerkes, 1920).

Based on his experience in the administration and scoring of intelligence tests during World War I, David Wechsler became keenly aware of the need for fairness regarding the evaluation of people who spoke English poorly and of the necessity of developing adult-oriented tests for adults. This paved the way for his Wechsler series of scales, starting with the Wechsler-Bellevue Intelligence Scale (Wechsler,1939), the Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R; Wechsler, 1989) for ages 3 to 7 years, the Wechsler Intelligence Scale for Children – Third Edition (WISC-III; Wechsler, 1991) for the ages 6 to 16 years, and the Wechsler Adult Intelligence scale- Third Edition (WAIS-III; Wechsler, 1997) for ages 16 to 89 years. Wechsler (1944) originally defined intelligence as the 'capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment'. He considered intelligence not as a global entity but also as an aggregate of scientific abilities. Wechsler explained that intelligence is global because it characterizes the individual's behaviour as a whole. It is also specific because it is composed of elements or abilities that are qualitatively different.

Wechsler's definition of intelligence also subscribed to the conceptualization of intelligence as an overall global entity. He believed that intelligence cannot be tested directly but can only be inferred from how an individual thinks, talks, moves, and reacts to different stimuli. He believed that intelligence should be measured by both verbal and performance tasks, each of which measured ability in a different way and which could be aggregated to form a general, global construct. Therefore, Wechsler did not give credence to one task above another but believed that this global entity called intelligence can be ferreted out by probing a person with as many different kinds of mental tasks as one can conjure up. Wechsler did not believe in a cognitive hierarchy for his tasks, and he did not believe that each task was equally effective. Each tapped many different mental abilities, which together reflect an individual's overall ability. Some require abstract reasoning, whereas others require perceptual skills, verbal skills and processing skills. All of these abilities are valued to varying degrees by our society, and all relate to behaviour that is generally considered intelligent in one way or another. None of the subtests, by itself, was designed to assess the entire range of cognitive abilities but each task was necessary for the fuller appraisal of intelligence.

Woodcock & Johnson developed an intelligence test in 1977 called the Woodcock-Johnson Psycho-educational Battery: Tests of Cognitive Ability (WJ; 1977) which made a major contribution to test development because of its inclusion of a diversity of novel tasks. It was during the decade of the 1980s that psychological theory was at last applied directly to the development of mental ability tests, like, Kaufman & Kaufman, 1983a; Thorndike, Hagen &

Sattler, 1986; Woodcock & Johnson, 1989. All of these theory-based instruments were clinical tests of intelligence designed to be administered individually to children or adults who were referred for psychological evaluation.

Theory has played a smaller role in group-administered tests of the multiple-choice variety. Yet group tests of intelligence are also important to society because of their prevalent use within the educational system, military services, industry and government service (Anastasi & Urbina, 1997). Occasional group tests have been theory based, most notably the S.O.I. Learning Abilities Test (Meeker, Mestyanek, Shadduck, & Meeker, 1975) developed from the Guilford's (1967) Structure of Intellect model of Intelligence.

Well-constructed and well-normed multilevel batteries include the Otis-Lennon School Ability Test (OLSAT; Otis & Lennon, 1997) for grades K-12, which is an updated and expanded adaptation of the original Army Alpha that was developed by Otis; the Cognitive Abilities Test (CogAT; Thorndike & Hagen, 1993) for grades K –12, which provides separate verbal, quantitative, and nonverbal scores; the Test of Cognitive skills (TCS/2 *technical report*, 1993) for grades 2-12, which includes four subtests at each level of the test, namely, sequences, analogies, verbal reasoning, and memory. The Naglieri Nonverbal Ability Test (NNAT); Naglieri, (1997) for grades 2-12, which is a brief nonverbal measure of reasoning ability using figural matrices and designs; and the 72 item Naglieri Nonverbal ability Test-Individual Form (NNAT-1) were built on the assumption that a nonverbal test of general ability would be appropriate for many different students as the nonverbal content puts every child on a level playing field (Naglieri, 2003).

These multilevel group administered intelligence tests and others like them usually avoid the word 'intelligence' in favour of terms such as 'school ability,' 'mental maturity,' or 'academic potential.' But what they measure is, indeed, what historically has been called intelligence. Most multilevel intelligence tests include the same subtests across virtually the entire broad age range (Kaufman, 2000).

Three new intelligence tests developed between 1989 and 1997 were the Woodcock-Johnson Psycho-Educational Battery- Revised: Tests of Cognitive ability (WJ-R, 1989), derived from Horn's expanded Gf-Gc theory; the 1993 Kaufman Adolescent and Adult intelligence Test rooted in the Horn-Cattell Gf-Gc theory and, to some extent, in Piaget's and Luria's theories; and the 1997 Das-Naglieri Cognitive Assessment system built to correspond to all three blocks of Luria's neuropsychological theory.

The WJ-R, one of the most comprehensive test batteries available for clinical assessment of children, adolescents and adults (Kamphaus, 1993), is a battery of tests for ages 2 to 90 years and is composed of two sections, namely, Cognitive and Achievement. The later is an individual measure of academic achievement while the Cognitive portion is based on Horn's (1985,1989) expansion of the fluid-crystallized model of intelligence, which encompasses about 8 to 10 separate abilities. The standard cognitive battery consists of seven subtests (one per Horn ability) and fourteen supplemental subtests aligned with seven of the cognitive abilities. These are Long-term retrieval (Glr or TSR), Short-term memory (Gsm or SAR), Processing speed (Gs), Auditory processing (Ga), Visual

31

processing (Gv), Comprehension –knowledge (crystallized intelligence or Gc), and Fluid reasoning (Gf). Each subtest and cluster score yields standard scores with a mean of 100 and a standard deviation of 15. One psychometric grouping of selected subtests permits the diagnosis of possible learning disabilities by comparing predicted to actual achievement in specific academic areas.

The Kaufman Adolescent and Adult Intelligence Test (KAIT) (Kaufman & Kaufman, 1993) is an individually administered test for individuals between the ages of 11 to more than 85 years. It provides fluid, crystallized, and composite IQs, each a standard score with a mean of 100 and a standard deviation of 15. It includes a core battery of six subtests (three fluid and three crystallized) and an expanded battery that also includes alternate fluid and crystallized subtests plus measures of delayed recall of information learned earlier. The Horn-Cattell theory forms the foundation of the KAIT and measures broad fluid and crystallized abilities rather than purer and more specific skill areas. Crystallized intelligence, within the framework of KAIT 'measures the acquisition of facts and problem-solving ability using stimuli that are dependent on formal schooling, cultural experiences, and verbal conceptual development' while fluid intelligence 'measures a person's adaptability and flexibility when faced with new problems, using both verbal and nonverbal stimuli' (Kaufman & Kaufman, 1993).

The Das-Naglieri Cognitive Assessment System (CAS; Naglieri & Das, 1997a), for ages 5 to 17 years, is based on, and developed according to, the Planning, Attention, Simultaneous, and Successive (PASS) theory of intelligence. Naglieri and Das (1997b)

linked the work of Luria (1966, 1973, 1980) with the field of intelligence when they suggested that PASS processes are the essential elements of human cognitive functioning. According to this theory human cognitive functioning includes four components: planning processes that provide cognitive control, utilization of processes and knowledge, intentionality and self-regulation to achieve a desired goal; attentional processes that provide focused, selective cognitive activity over time; and simultaneous and successive processes that are the two forms of operating on information. The CAS was designed to mirror the PASS theory with subtests organized into four scales designed to provide an effective measure of each of the PASS cognitive processes. The CAS yields scores for the Planning, Attention, Simultaneous, Successive, and Full-Scale that are normalized standard scores with a normative mean of 100 and a standard deviation of 15.

A few nonverbal intelligence tests developed during 2000-2003 are worth mentioning. This includes the Universal Nonverbal Intelligence Test (UNIT)(McCallum, 2003) which is multidimensional and primarily addresses memory and reasoning using both a symbolic and non-symbolic format. The Comprehensive test of Nonverbal Intelligence (CTONI) (Pearson,2003) designed to provide an estimate of intelligence of individuals not proficient in English or who are motor impaired or language disordered. The Leiter-R (Roid,2003) a comprehensive, non-verbal battery for ages 2-0 to 20-11, that provides IQ, composite and profile scores, effective for preschoolers and low functioning individuals. The General Ability Measure for Adults (GAMA)(Bardos, 2003) is a nonverbal test designed to evaluate an individuals overall general cognitive ability. It offers numerous advantages when an alternative instrument is needed to estimate a person's overall cognitive ability. Test of

Nonverbal Intelligence, Third Edition (TONI3)(Brown,2003) is a highly standardized, norm referenced measure of abstract reasoning and problem solving and relatively free of bias with regard to gender, race ethnicity and other relevant variables.

Daniel (1997) has categorized the historical and developmental status of intelligence testing into three, namely, (i) test of psychometric abilities, (ii) tests based on neuropsychological-processing models, and (iii) dynamic assessment. The test of psychometric abilities refers to abilities that have been identified through factor analysis of sets of diverse cognitive tasks (for example, verbal and spatial abilities, inductive reasoning, and memory). Intelligence batteries in this category tend to be interpreted with respect to a model of the structure of abilities that itself is based on findings from factor analysis. Some of these type of tests are: Wechsler's Intelligence Scale for Children (Wechsler,1991) which offers four factors- verbal comprehension, perceptual organization, processing speed, and freedom from distractibility; Third edition of Wechsler Adult Intelligence Scale (Wechsler, 1997); Forth edition of Stanford-Binet intelligence scale (Thorndike, Hagen, & Sattler, 1986) which measures crystallized intelligence- visual reasoning, quantitative reasoning, abstract-visual reasoning and short term memory; the Kaufman Adolescent and Adult Intelligence Test (Kaufman & Kaufman, 1993) focuses on fluid and crystallized intelligences while also assessing immediate and intermediate-term memory, whereas the Woodcock-Johnson Tests of Cognitive Abilities-Revised (Woodcock & Johnson, 1989), the most thorough implementation of a multifactor model, assess seven dimensions of ability. The swing toward a multifactorial model of intelligence, however, has not been accompanied by a general rejection of the concept of *g*. All the aforementioned

batteries provide a score representing the general factor. The long standing argument over general intelligence versus multiple abilities has given way to a broad acceptance of a hierarchical model in which abilities are nested under a higher order general factor, each level having a substantial amount of explanatory power.

Tests based on Neuropsychological-Processing Models include the Kaufman assessment battery for Children (K-ABC, Kaufman & Kaufman, 1983) and the Das-Naglieri Cognitive Assessment system (CAS, Naglieri & Das, 1997), both of which are based on Luria's (1973, 1980) model of functional processes. Although the psychometric-ability tests are designed around models that have grown gradually as empirical evidence has accumulated, the content of tests based on Luria's neuropsychological model tends to be theoretically driven. Conceptualization of intellectual functioning based on neuropsychological understanding of how various regions of the brain may function is valuable, especially if the brain itself is considered responsible for intelligence. This approach offers the greatest hope for increased validity of intelligence tests because it provides a model of functioning that rests on components of the functioning brain (Das, Naglieri & Kirby, 1994). Luria's (1973, 1980) model posits three functional levels, each associated with a region of the brain. Arousal and attention are at the lowest level; at the next level, information is encoded and processed in either simultaneous or successive fashion; and planning and monitoring functions make up the highest level. The K-ABC assesses the two coding processes (simultaneous and successive), whereas the CAS adds subtests for attention and planning.

Dynamic assessment refers to the diverse approaches that share some basic assumptions. It attempts to provide several types of information: (a) more valid measures of the abilities measured by static tests; (b) measures of different abilities, particularly learning ability or modifiability; (c) insights into the cognitive processes the examinee uses or fails to use; and (d) clues about the instructional methods that are most effective for the examinee (Campione & Brown, 1987; Embretson, 1987; Haywood, Brown & Wingenfield, 1990). The dynamic assessment approach is less concerned with the structure of abilities and more interested in a different aspect of intelligent behaviour, namely, the ability to learn. Dynamic assessment techniques may be divided into two groups according to the administration procedures they use. One type uses clinical, nonstandardized intervention by the examiner to reveal the cognitive processes in which the examinee is weak, to identify effective intervention methods, and to improve the examinee's cognitive processes. The learning potential assessment device by Feuerstein, Rand & Hoffman, 1979 is the best-known example of a dynamic assessment tool. The other subgroup consists of approaches that provide standard rather than clinical interventions and that use objective measures of the number and types of prompts or hints required, the amount of growth following intervention, or the post intervention score as primary outcome variables (Campione & Brown, 1987; Embretson, 1992; Guthke & Stein, 1996; Swanson, 1996). The Swanson Cognitive

Processing Test (Swanson, 1996) is the only normed, formal instrument which yields scores for working-memory task performance before and at various points during and after

training, the amount of improvement with intervention, the number of hints given, and examinees' reports of strategy use.

CHAPTER 3

INTELLIGENCE TESTING IN INDIA

S.M. Mohsin is one of the pioneers of intelligence testing in India. He constructed an intelligence test in Hindi in the 1930s. Long and Mehta prepared a mental measurement handbook in 1966 listing out 103 tests of intelligence developed in various Indian languages. The Bhatia test is one of the more popular tests of intelligence in India (Dash & Mohanty, 2004). An intelligence test to assess the mental abilities of Indian adolescents ranging in the age from 13-18 was developed by Jalota in 1971. The items constituting the test related to (i) vocabulary,(ii) classification, (iii) number series, (iv) analogies and (v) reasoning.

Among the other tests of intelligence is Sharma's Draw – A - Bicycle Test (Sharma,1977) standardized on a population of 11 to 16 years age group. The author pointed out that in drawing a man the variations in his dress and sex were related to the different exposures dependent on the region, family background, while the bicycle represented a relatively homogeneous stimulus situation. However, certain inadequacies of the test as highlighted by Mukherjee (1980) reflected the weakness in the theoretical/conceptual framework particularly relating to 'what' the test measures as there was a complete absence of any discussion of the construct of intelligence.

Phatak (1984) reported a revision of her Draw-a-Man (or Woman) scale and its extension downward to 2 ½ years and upward to 16 ½ years. The norm sample was from eight schools in Pune. The sample size of different age groups ranged from 59 to 122, but there were only 10 subjects in the age group of 16 years (boys and girls both). The correlation (Rho) between the revised scale scores and examination marks ranged from .015 (at 6 years) to .435 (at 8 years). The range of the correlations between the revised scale scores and drawing marks was .121 to .867 with an average of .60.

Sinha (1977) also developed a Draw Yourself test. In this test subjects, both boys and girls, ranging from 8-10 years of age draw their own pictures. She found that the Draw Yourself test is a better measure of school achievement than the Draw-A-Man (or Woman) test though it does not measure intelligence as is done through other tests of verbal and non-verbal intelligence tests. A novel attempt was made by T. Padmini in 1984 in using Rangoli Pattern Drawing, an indigenous art practiced by young girls in South India, and related these scores with those on Raven's Coloured Progressive Matrices (CPM). The sample consisted of 280 school students (girls) ranging between 8-11 years of age from low-middle or worker-class families. The study raised doubts about the cultural fairness of the CPM test although there was a positive correlation between the two tests (Kulkarni & Puhan,1988).

Another intelligence test developed by Dubey (1977) is the Reasoning Ability Test in Hindi which claims to measure inductive and deductive reasoning. It consists of 40 items of number series type and 20 items of arithmetic reasoning. The internal consistency

reliabilities of the test are found to be .89 to .91. Validities are reported in terms of the tests correlations with a Group Test of intelligence (Jalota & Tandon, 1971), Progressive Matrices, and his own Problem Solving Ability Test. These three correlations range from .836 to .875.

Desai (1980) studied the comparative factorial structure of Raven's (1947) Progressive Matrices, Cattell and Cattell's (1959) Culture Fair scale:3, and Desai-Bhatt group Test of Intelligence on samples of various social subgroups of Gujarat. His study supports Cattell's theory that culture fair tests like those of Cattell or Raven are better measures of fluid intelligence while the verbal tests of intelligence like Desai's are measures of crystallized intelligence.

The factorial and psychometric invariance of Raven's Progressive Matrices (1947) and Wechsler Adult Intelligence Scale (1955) was studied by Puhan over a series of well-designed studies (1978c,1979a,1979b,1979c,1982). He demonstrated that these tests do not remain the same over different age groups as well as different cultural groups. Sinha (1977) studied the validity of Progressive Matrices by using age and school examination marks as criteria on a sample of secondary school students in Patna. All the correlations between PM and age were found to be significant. However, correlations between PM and school examination marks were found to be low.

A well-designed attempt was made by Ram (1978) to develop measures of intelligence and social maturity for diagnosing mental retardation. She constructed the tests in Marathi

language for the age group of 5 to 10 years and standardized it on a sample of Pune school children. The factor analysis of this test yielded a general and a perceptual factor. The social maturity scale was constructed by employing Thurstone's equal appearing interval technique. The multiple correlation between IQ and maturity checklist on the one hand, and psychiatric social worker's overall diagnosis of mental retardation on the other hand was .81 which was much higher than that obtained by an IQ test alone.

A comprehensive project in the area of intelligence test development was carried out by Khire (1999) and her team of researchers. She developed a battery of 90 tests basing them on Guilford's model of structure-of-intellect (SOI). The test has been standardized by administering them to a stratified sample of 4322 students from rural and urban population and metropolitan schools in Maharashtra. Factor analysis indicated the extremely poor performance of students on different ways of thinking including tasks involving transformation, redefinition, implication and divergent thinking.

According to Kulkarni & Puhan (1988) some researches have left the trodden path of testing conventional intelligence and are exploring the field of cognitive development more or less on the lines of Piaget. One such attempt was made in the Child Study Unit of NCERT (Bevali, 1981;1984; Muralidharan & Kaur, 1984). The team adapted cognitive tasks from the original Piagetian tasks for studying the levels of development of the concept of speed. Bevali studied three age groups, 6, 9 and 12 years from a public school catering to high, middle, and lower class children in a municipal corporation school in an urban area of Delhi and a nearby rural school. She also collected data on children's intelligence as

measured by Draw-A-Man test, socio-economic status and educational background of both the parents. The inter-rater reliability of scoring the responses was reported to be quite high.

Cognition is involved in almost everything a human being does. It is the process of gaining information and of understanding the world (Broota, 1988). Cognition is "an expression for every process by which a living creature obtains knowledge of some object or becomes aware of its environment" (Eysenck, Arnold & Meili, 1975). According to Neisser (1967), "such terms as sensation, perception, imagery, retention, recall, problem solving and thinking among many others refer to hypothetical stages or aspects of cognition".

Piaget's theory of cognitive development had spurred a great deal of research during the 70's and 80's. Research on the concrete operational period which attracted the attention of the other researchers has been chiefly on conservation, be it quantity, weight, volume, length, area, or number. Bevali (1981,1984) observed that the development of cognitive operations involved in the concept of speed among Indian children followed the same pattern as those of Genevan children studied by Piaget. However, differences are found in the ultimate level reached and the speed of development depending upon the type of environment in which the child functions. Her results also suggested a systematic delay in the case of rural children as compared to urban children, and within the city in the case of socially disadvantaged as compared to socially advantaged children. At least two to three years delay was noticed in the advantaged group as compared to western children. School-wise analysis showed significant sex differences in the urban advantaged group. It was

suggested that these differences were more environmental and experiential. Further, intelligence was found to be highly correlated with the concept of speed.

Das and Dash (1983) also studied the developmental levels of cognitive representation by employing a different technique similar to Pearson and Maddi inventory to measure variety or novelty. They constructed a 10 item inventory where each item was provided with five alternatives reflecting concrete to abstract order of similes. Child was required to select the most appropriate simile. They found that higher age children from grades 4, 5, 6 and 7 of a rural middle school prefer more abstract similes. The finding was in consonance with Piaget's stages of cognitive development. Dash and Rath (1984) also reported that eight weeks of intensive training considerably improved the scores of these children on certain cognitive abilities like on Visual Reception and Association subtests of Illinois Test of Psycholinguistic Abilities (ITPA), Draw-A-Design and Draw-a-Child subtests of McCarthy Scales. Rath and Patnaik (1979) also reported that disadvantaged children improve their scores on Raven's PM and Wechsler-type reasoning after short prior training indicating the effect of training on the scores of intelligence tests.

Dash and Das (1984) reported a study on development of concrete operational thought and information coding in schooled and unschooled children from fourteen villages in Orissa with homogeneous demographic characteristics. All subjects were administered tests of simultaneous (Figure Copying and Memory for Design) and successive Auditory Serial Recall and Digit Span processing. In addition, half the children in each group who were randomly selected were administered four Piagetian tasks, that is, conservation of length,

conservation of mass, transitive inference and class inclusion. As predicted, performance on Piagetian tasks increased as a function of age only, whereas the effects of schooling, age, and their interaction were clearly observed for coding processes. The authors also concluded that information processing modes rather than concrete operational skills is more sensitive to the cognitive consequences of schooling.

A comprehensive study of language development for children ranging from 2 ½ to 5 years was conducted by the Child Study Unit of NCERT (Bevali, 1984). The tests used were Naming and Identification of Pictures, Naming and Use of Objects, Comprehension Test, Comprehension of Time, Right and Left, Ability to Identify Oneself, Action Agent Test, Responses to Humour, Following Directions, Following Prepositions, Indicating Parts of the Body, Responses to Picture Cards and Responses to Picture Books. The overall inter-scorer reliability was found to be .95. The cross-sectional study included both urban and rural children in and around seven centers spread all over India. The longitudinal study, however, was conducted in the urban centers only. The effect of home, school and individual variables on the cognitive development of Indian children coming from disadvantaged environment were also studied on a cross-sectional sample of 664 children in the age group of 5 ½ to 11 years from municipal corporation schools in and around Delhi. Out of the 25 variables studied, socio-economic status of parents, especially education and income ratio of the family, facilities for play, school facilities and intelligence were found to be highly correlated with the Piagetian conservation tasks measuring concepts of number, length, areas, and volume as well as the composite overall score of all the concepts taken

together. The team has also studied the influence of a stimulating environment in the home and school on cognitive development.

Murlidharan and Kaur (1984) studied the impact of intervention programs on language and cognitive development of tribal preschool children. They assessed the instructional materials prepared by the children's media laboratory in terms of their usefulness for cognitive development of tribal children in Tokapal block of Bastar district, Madhya Pradesh. Of the 10 cognitive tools they used, nine were prepared specifically to suit the local environment and the tenth was Phatak's Draw-A-Man test. These tools were Object Vocabulary, Action Picture Reading, Oral Expression, Listening Comprehension, Environment Acquaintance, Sequential Thinking, Time Perception, Shape Discrimination and Colour Discrimination Tests.

The emphasis on maturation in Piaget's theory has raised questions about the effect of experience on cognitive development. Narayana Rao (1977) examined the role of experience in the development of conservation of mass, weight, and volume. Conservation responses were found to vary significantly with age. Conservation for mass gradually increased from the age of 4 years till about 6 ½ years when there was a very sharp increase. If the child exhibited conservation on one kind of experimental material, the response was observed in relation to other materials as well; conservation of mass was not always accompanied by conservation of weight and volume, but conservation of volume was usually accompanied by conservation of mass and weight. According to Narayana Rao (1977), "structures acquired at a lower level may be used at a higher level but this is not

45

necessarily guaranteed. On the other hand, the structures evidenced at a higher level-volume conservation- would imply the operation of similar structures at lower levels- mass and weight." Significant differences were observed between high and low socio-economic groups which increased with age (above the age of 5 ½ years). Gupta (1981) investigated perception of horizontality using Piaget's water level task to present tilts at various levels. He reported significant differences in the judgment of water levels among males and females.

Iyengar and Jain (1979) investigated the effect of sensory deprivation on the development of conservation of liquids. They found that (a) the growth of conservation began at a later age among sensorial deprived children, and (b) sensorial deprived children relied more on perceptual cues in justifying their judgments.

Narayana Rao and Reddy (1977) studied the relation between a child's background and the emergence of causality and the concept of life. The amount of schooling was found to be related to concept acquisition. Children from the same age levels, but with more years of schooling, were superior to their counterparts who had less schooling. Causal relations were better among urban and among those from educated families, but no differences were evident in relation to the concept of life. The socio-economic background of the family did not appreciably affect the acquisition of concepts at any age level (5-9 years). However, the concept of life was better developed than the concept of causality.

Psychologists, according to Kulkarni and Puhan (1988) have also pointed out the need for exploring new dimensions of cognitive abilities on the industrial front. The competencies required at the adult level, like judgment and decision making, should be appropriately measured in intelligence tests for that level rather than scholastic ability which usually has a higher weightage in conventional intelligence tests. Puhan (1982) reported that even for WAIS the factor structures at ages 18-19 and 25-34 were very different.

While studies in cognitive development have essentially utilized Piagetian tasks, investigations related to ability testing in children have predominantly used psychometric measures (Saraswathi & Dutta, 1988). Findings pertaining to developmental trends in early childhood indicate that the Developmental Quotient (DQ) of infants in the first 30 months of life is characterized by stability in mean DQ with a high degree of individual variation (Bhakoo, Kaur, Narang & Verma, 1977), some of which may be due to methodological problems in scoring. Further, no substantial change in the nature and composition of general intelligence as measured by the Binet-Kamat Test of Intelligence has been noted during the age period 4 to 7 years (Chattopadhyay & Bhattacharya, 1981b).

No significant difference in performance of children born in the United Kingdom of British or Indian origin on a battery of abilities tests were observed by Cox, Bryand & Agnihotri, 1982. In general, performance of children in India was lower, but was poorest among the recent immigrants to the U.K. which according to the authors was indicative of the problems of recent immigration. Further analyses of the reasons for differences in the test performance of western and Indian children was provided by Pershad, Verma & Randhawa (1979), and

47

Verma, Pershad & Randhawa (1980) who suggested that changes in access to western forms of education as well as differences in test administration may account for the observed differences.

A test of reasoning in which verbal syllogistic types of items were included was developed by Kundu and Chakraborty (1979). After item analysis two parallel forms of tests each having 15 items were standardized. They reported reliability coefficients were between .98 and .94 and the validity criterion was the inference subtest of the NCERT General Mental Ability Test. The validity coefficients were .69 and .72. In another study Chakraborty and Kundu (1979) administered the NCERT test of general ability (9 number series items) to 80 superior male and female students. For each solution the subjects were required to give details of the reasons that led to the solution. Three judges separately rated the responses on a 5-point scale for 7 separate dimensions (Tripathi, 1988).

As can be seen not many intelligence or mental ability tests have been developed in India for our population. A few of the tests which have been developed have been elucidated in the subsequent pages in a tabular format. It may be noted that the reliability and validity indices of most of the tests are not readily available.

Development of Intelligence Tests in India.

Name	Author	Applicability	Measures	Reliability	Validity
Divergent Production Abilities Test	K.N. Sharma	Children, adolescents and adults	Divergent thinking	Test-retest established-0.67 to 0.85	Product moment correlation with Baqer Mehidi test of creative thinking.
General Mental Alertness	R.P. Srivastava	College Students	Intelligence (Quantitative, numerical, linguistic and reasoning)	$r = 0.79$ to 0.85	Correlation with Thrustone Test of Mental Alertness .88.
Non-verbal Intelligence Test	Atmanand Sharma	10-16 years	Non-verbal intelligence	Split-half 6th grade-r=0.92, KR_{21}=0.77, SEM=1.35. 8th grade-r=0.94, KR_{21}=0.78, SEM=0.98 10th grade-r=0.90, KR_{21}=0.75,SEM=1.46	Predictive Power.
Humanities Group Test of General Mental Ability	Mohan Chander Joshi	School students	General mental ability	$KR_{21} = 0.863$	Factorial Validity, Predictive Validity, External Validity.

Name	Author	Applicability	Measures	Reliability	Validity
Test of General Mental Ability	M.C. Joshi	12-20 years	Mental ability	Test-Retest 0.88	Correlation with other test-0.8
Group Test of General Mental Ability	S. Jalota	12-18 years	General mental ability	0.96	Factor analysis with centroid method and External criterion-related validities
Draw-A-Man (or woman) Test.	Dr. Pramilla Pathak	2 1/2 –16 1/2 years	Growing mental status	Test-retest 0.62 to 0.96	External criterion 0.13 to 0.69/correlations on intelligence and reading ability-0.13 to 0.24 correlation with Good Enough's Draw-A-Man Scale-0.87
Group Test of Intelligence	Pramila Ahuja	9-13 years studying in 5th to 6th grades	Intelligence to place and guide the students	Split-half 0.89 to 0.94. Test-retest-0.85 to 0.97	Obtained validity coefficients from 3 tests of intelligence-0.56 on Dr. Nafde's Non-verbal test of Intelligence; 0.73 on Beren's Scholastic Aptitude Test and 0.73 on Ahuja's Group Test of Intelligence

Name	Author	Applicability	Measures	Reliability	Validity
Group Test of General Mental Ability (A 5-point Scale for Adults).	S.Jalota and R.K. Tandon	15 years and above belonging to English speaking areas	General mental ability	Split-half, K.R. formula, item reliability index and variance	Validity with Exam Marks-0.35
W.A.P. Intelligence Scale	P. Ramalinga swamy	15-45 years.	Adult Intelligence	Reliability index not available	Construct and factorial validity
Reasoning Ability Test In Hindi	L.N. Dubey	12-17 years.	Inductive reasoning and Deductive reasoning	Rational Equivalence, Split-half ranging from 0.89 to 0.91	Validity against criterions, concurrent validity (0.836-0.875)
Draw-A-Man Test.	A.N. Mishra	6-10 years.	Mental growth level and abnormality in a child.	Test-retest 0.99, split-half 0.847	Intrinsic validity-0.99, reported rho value-insignificant
Sharma Draw-A-Bicycle Test of Intelligence	T.R. Sharma.	11-16 years.	Children's conceptual and intellectual maturity.	Test-retest-0.82, split-half-0.84-0.92, full test-0.91-0.95.	Validity against external criterion is reported

Name	Author	Applicability	Measures	Reliability	Validity
Verbal Intelligence Test	R.K. Ojha and K.R. Chowdhary	9th to 12th grades, 13 to 16 years	General intelligence	Split-half and K.R. formula	Intercorrelation of 8 sub tests-0.348 to 0.574
OTIS Self-Administering Test of Mental Ability, Form B	Hindi adaptation by N.S.Chauhan, G.Tiwari, Original by A.M. OTIS and T.N.Bures	Students of intermediate class	Intelligence	Form B Coefficient of correlation. P.E.-0.002, Form C.Coefficients of correlation-0.036	Parallel test and self-correlation
Problem Solving Ability Test	L.N. Dubey	12-17 years	Numerical Ability	Split-half, K.R. formula	Correlated this test with Group Intelligence Test and test of reasoning ability
Problem Solving Ability Test	Roopa Garg	12-19 years	Problem solving ability and level of intelligence	Split-half 0.683, Rational Equivalence 0.791	Correlated the test score with scores on group intelligence test
Chandra Mohini Budhi Parikshan	Chandra Mohini	Students of XI and XII of Hindi Medium	General intelligence	Full test 0.71 & 0.95, K.R. formula-0.70 and 0.81, Test-retest-0.80, Rolon formula-0.8, 0.90, 0.93	Predictive validity, Concurrent validity 0.520

CHAPTER 4

METHODOLOGY

DEFINITION OF MENTAL ABILITY FOR THIS RESEARCH

Mental Ability has been defined, for the purpose of this research, as the basic reasoning ability of an individual which he or she applies in problem solving of many kinds. Importance of reasoning ability is attested by the fact that it is always the largest factor in any factor analysis of abilities (Kline, 1990).

AIM

The aim of this study was to develop a test of mental ability for school children (belonging to the age group 12-17 years old) of Indian origin which include both verbal and non-verbal stimuli.

SAMPLE

The sample for the study consisted of 600 school boys between the age range of 12-17 years. The break up of the sample for the different phases of the study was as given in the table:

SL No	SAMPLE SIZE	DIFFERENT STEPS OF TEST DEVELOPMENT
01	200	ACTUAL TRY-OUT OF NEW TESTS
02	200	TIME FIXATION & RELIABILITY INDICES
03	100	VALIDATION
04	100	DEVELOPMENT OF NORMS
05	**600**	**TOTAL SAMPLE**

The boys were studying in government aided schools, in classes 8th, 9th, 10th and 11th. The schools were located in and around Delhi. More than 40% of the boys were first born and resided in nuclear families. The boys had knowledge of English as that was a subject taught in the school and could follow the instructions of the tests which were in English. The hobbies ranged from playing team games like cricket, hockey and football to watching television. The educational qualification of the parents of this sample varied from being school dropouts to post graduation. The fathers of 35% boys were post graduates and were working in different governmental organizations, 25% were graduates and the rest were undergraduates. Only 4% mothers of the boys in this sample

were post graduates, 20% were graduates and the rest were undergraduates and school dropouts.

DESIGN OF THE STUDY

The study was conducted in two phases, Phase-I and Phase-II.

PHASE-I

Phase-I consisted of the following:

Aim- The aim of this phase was to develop a test of mental ability for school children.

Sample- The sample for this phase consisted of boys in the age range of 12-17 years, 40 each from the age range of 12-13; 13-14;14-15;15-16; and 16-17 years.

Methodology- The following steps of test construction were used for the completion of this phase. Each of the steps would be explained in detail in the subsequent sections.

(a) Determining the components to be included in the measurement of mental ability. It included identifying both verbal and non-verbal dimensions of measurement of the construct.

(b) Construction of an item bank for both verbal and non-verbal items encompassing the components identified for the measurement of mental ability.

(c) Scrutiny of the items by a panel of specialists or experts well versed in test construction.

(d) Preliminary try-out of the item bank based on the suggestions of the experts.

(e) Actual try-out of the item bank for item analysis on the sample mentioned above along with the personal data sheet for measuring biographical variables.

(f) Item analysis to determine the item selection through item difficulty and item discrimination of all the items of the preliminary test.

(g) Preparation of the final forms of both verbal and non-verbal items based on graded difficulty level.

Outcome- After following the steps enumerated above the development of the mental ability test for school children was completed by the end of this phase.

PHASE-II

Phase-II consisted of the following:

Aim- The aims of this phase was, firstly, to establish the optimum time limit for both the verbal and non-verbal mental ability test, and secondly, to establish the reliability and validity of the newly developed mental ability test for children. Age norms was also developed in this phase.

Sample- The sample for this phase consisted of boys in the age range of 12-17 years, approximately 40 each from the age range of 12-13; 13-14; 14-15;15-16; and 16-17 years for the establishment of reliability and validity indices and 100 boys of 15-17 years for the development of norms.

Methodology- The following steps were used for the completion of this phase:

(a)   Time fixation was done by administering both the final forms of the mental ability tests to the sample mentioned above. Each test was administered on the sample under three different timings. Nature of the distribution of the scores for each of the timings for both the verbal and non-verbal tests was computed to establish the optimum time limit.

(b)   Reliability of both the tests of mental ability was established using the Rational Equivalence Method.

(c)   Validity of both the tests of mental ability was established by correlating the scores achieved by the sample on the standardized and well accepted Raven's Standard Progressive Matrices and also correlating the mental ability scores with school academic achievement of the subjects.

Outcome- By the end of this phase the optimum time limit for both the verbal and non-verbal tests were established. The reliability and validity indices were also established.

CHAPTER 5

CONSTRUCTION OF ITEMS

COMPONENTS INCLUDED IN THE MEASUREMENT OF MENTAL ABILITY

For the purpose of determining the components that should be included in the measurement of mental ability as defined in this project the 'factor structure of human abilities' as elucidated by Carroll (1993) has been taken. He suggests that this factor structure draws a fair amount of consensus from a number of psychologists.

PRIMARY FACTOR ABILITIES- HAKSTAIN AND CATTELL (1974)

V	Verbal ability	Understanding words and ideas, eg., synonyms, meaning of proverbs, analogies
N	Numerical facility	Facility in manipulating numbers
S	Spatial ability	Ability to visualize two-or-three dimensional figures when their orientation is altered
P	Perceptual speed and accuracy	Assessing whether pairs of stimuli are similar or different

Cs	Speed of closure	Ability to complete a gestalt when parts of the stimulus is missing
I	Inductive reasoning	Involves induction, reasoning from the specific to the general
Ma	Associative or rote memory	Memory for pairs for which no mediating link exists
Mk	Mechanical ability or knowledge	
Cf	Flexibility of closure	Involves disregarding irrelevant stimuli in a field to find stimulus figures
Ms	Span memory	Short-term recall of digits or letters
Sp	Spelling	Recognition of misspelled words
E	Aesthetic judgment	Ability to detect the basic principles of good art and like Mk this would appear to depend much on previous experience
Mm	Meaningful memory	Involves the learning of links between pairs in which there is a meaningful link
Fl	Ideational fluency	Ability to reproduce ideas rapidly on a given topic
W	Word fluency	The rapid production of words, conforming to a letter requirement, but without meaning
A	Aiming	Involving hand-eye coordination at speed
Rd	Representational drawing ability	Drawings of stimulus objects scored for precision of lines and curves

SECOND ORDER FACTORS UNDERLYING PRIMARY FACTORS (Horn and Cattell, 1966)

Gf	Fluid intelligence	Includes inference, induction, memory, span and flexibility of closure
Gc	Crystallized intelligence	Loading on verbal, mechanical, numerical and social skills factors
Gv or Pv	Visualization	Loads all skills where visualization is helpful, spatial orientation, form boards
Gr	Retrieval capacity or general fluency	Loading on ideational fluency, association fluency and irrelevant association test, it is general retrieval power which accounts for a variety of skills
Gr	Cognitive speed factor	Affects speed in a wide range of tasks although it is a minor factor in solving of problems. This is speed in mechanical performance, example, writing or numerical computation

STEPS INVOLVED IN CONSTRUCTION OF THE TEST

Almost all psychological test are constructed and standardized in a similar way, the only difference lies in the purpose of the test and in the content of items. The construction of a test and its standardization are two different but

related concepts. In test construction, after item analysis, the items are finally chosen whereas in standardization the chosen items are administered on large groups and then standard norms are prepared according to the results. In other words, test construction is one of the steps in standardization. A test can be constructed and may or may not be standardized, but for standardization, a test must be constructed. Usually, many tests are constructed for a special purpose and beyond this purpose they have no value but the tests which are standardized can be used for a wide range of purposes (Chadha, N.K.,1996) Generally, for all psychological test construction the following five steps are used:

1. Planning the test
2. Preparing the preliminary draft of the test.
3. Trying out the preliminary draft of the test.
4. Evaluating the test.
5. Construction of the final draft of the test.

Planning the test-The first task of a test constructor is to produce the outline of the desired test, i.e., the plan of the test. For this purpose, the subject, medium, administration, procedure, sample, population etc. are established and age, sex, educational qualification, mother tongue, rural/urban, socioeconomic status and other environmental factors must be considered. The particular mental or behavioural characteristics to be clearly stated before test construction is undertaken. The test constructor himself sets the purpose of the test, which must be clear, relevant and in tune with the behaviour of the subjects.

After the aim has been established, the subject matter is decided, keeping the aim of the test in mind. As for this research the purpose was to measure the intelligence of students up to 17 years of age, therefore, the subject matter was such that it appropriately measured the required abilities. Therefore, the content of the test was verbal, numerical and also non-verbal, that is, pictorial.

Besides the format of the test (paper-and-pencil or performance; verbal or non-verbal), its medium (Hindi, English, or any regional language), the way it has to be administered (individual, group or both), the amount of money and time involved, characteristics of the subjects such as their age, sex, ability, experience, etc. of the subject were also taken into consideration.

Thus, in the first step of test construction, the following four points were considered:

1. Arrangement of assessment of the test objectives.
2. The objective for which the test was being constructed.
3. Reflection of the objectives in the test items. The items for the test should be in accordance with the objectives of the test.
4. What would be the form, medium and language of the test and under which conditions it would be administered to persons of a certain age, sex etc.

Preparation for the preliminary tryout of the test- All types of items required for the test were constructed in pre-tryout form. The types of items are described in the subsequent section on 'Types of Mental Ability Test Items'.

TYPES OF MENTAL ABILITY TEST ITEMS

With definition of mental ability as the basic reasoning ability, the ability to educe correlates and perceive relationships, different types of items were constructed to measure this ability. The types of items which have been developed for this mental ability test are described below:

1. ANALOGIES

Analogies are used in testing for the 'g' factors because their solution involves educing the relevant relationship in the first part of the analogy and applying it to the rest of it. The difficulty level of analogies is simple to manipulate, both in respect of the actual relationship which has to be educed and (of less importance) as regards the obscurity of the objects to be related. Analogies has been extensively studied by Sternberg (1977) in an attempt to elucidate the cognitive processes which were involved in solving problems requiring intelligence. Analogies can be used to measure both crystallized as well as fluid intelligence. Relationships between letters

64

in the alphabet and numerical relationships that do not require any complex mathematics can all be tested within analogies. Furthermore, nonverbal visual items based on spatial configurations can be also used.

Analogies are designed to measure candidates ability to deal with abstract ideas. The candidate is required to comprehend the relationship between the first two objects/ figures and apply the same reasoning to find out the correct answer.

Analogies can be composed from any of a number of different kinds of content (e.g., verbal, geometric, schematic-picture) and any of a number of different kinds of formats (e.g., fill-in-the-blank, true-false, multiple-choice).

EXAMPLE

VERBAL ANALOGIES

Instruction: Two objects, events or concepts are related in some way. You have to establish the same relationship with the third and the fourth object, event, or concept on the basis of the alternatives given below each question.

(A) Metre : ? :: Litre : Volume

    (a) Weight   (b) Length   (c) Square   (d)   Area

(B) Tree and Forest

    (a) Ocean and Ships   (b) Books and Letters

    (c) Books and Library   (d) Boys and Teacher

(C) ABC : ZYX :: CBA : ?

    (a) ZXY   (b) BCA   (c) XYZ   (d) XZY

NON-VERBAL ANALOGIES

Instructions: Each of the following questions consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

Problem Set   Answer Set

W   X   Y   Z   A   B   C   D   E
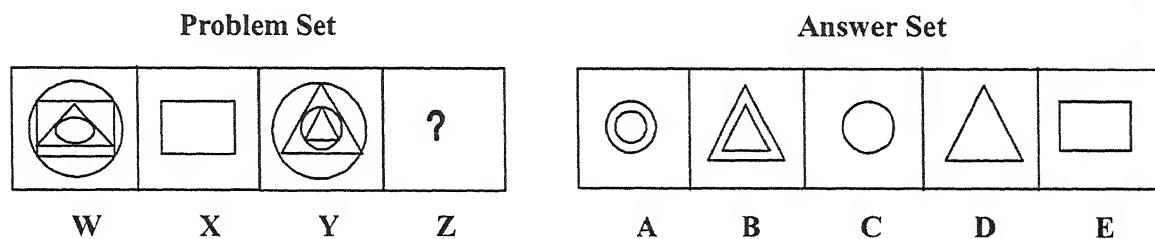
2.   CLASSIFICATION OR ODD-MAN-OUT

Odd-man-out items consists of sets of, for example, nouns or verbs, or objects, or numbers, or shapes, of which all but one fall into a category. The subject has to pick out the one which does not fit. This entails, again, the subjects having to educe the relationship between the items to establish the

similarities and differences and the basis of class membership. This form of item can also be easily manipulated in terms of difficulty level, both of relationship and information required.

These items are designed to assess the candidate's ability to see through similarities and differences of objects/ figures. The candidate is required to find out one of the five objects/ figures which is different and does not belong to the same class. Classification can be presented in verbal form, or in any of the forms applicable to the other kinds of induction problems like numbers, geometric forms and schematic pictures. Sometimes subjects are required to find more than one item that does not belong with the others or the subjects may be required to indicate which of several answer options fits best with a set of given items.

EXAMPLES

VERBAL ODD-MAN-OUT

Instruction: Find out the word which does not belong to the same class as the others.

Potato, Radish, Onion, Ginger, Tomato

(a) Potato   (b) Onion   (c) Tomato   (d) Ginger

Instruction: In the group of the following numbers one does not belong to the group. Which is that number?

(a) 7   (b) 16   (c) 13   (d) 19   (e) 5

Instruction: Three of the following letter groups are alike in a certain way and so they form a group. Which is the one that does not belong to the group?

(a) ABA   (b) DED   (c) KLL   (d) GHG

NON-VERBAL ODD-MAN-OUT OR CLASSIFICATION

Instruction: Out of the five figures (A), (B), (C), (D) and (E) given in the problem four are similar in one way. However, one figure is not like the other four. Choose the figure which is different from the rest.
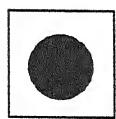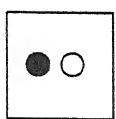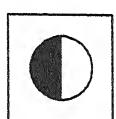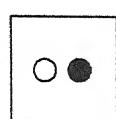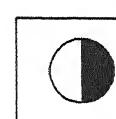
A   B   C   D   E

3.   SERIES OR SEQUENCES

This item form is suited to verbal, alphabetical (letter series), numerical and nonverbal items, thus making it useful for testing both the 'g' factors, that is, crystallized as well as fluid. With numerical series items care is also taken regarding solutions for that should not involve too much mathematical knowledge or reasoning, which are both distinct from the 'g' factors.

According to Carroll (1983), series is one of the best markers on the fluid ability factor.

In this type of items, letters/figures are arranged in same systematic order so as to constitute a series. The items are intended to measure a candidate's ability to comprehend the relationship amongst the figures and then apply the same to solve the item correctly.

EXAMPLES

VERBAL SERIES

Instruction: Write the numbers which will come next in the series.

(A)   7,11,13,17,19,23,_,_,_

This numerical sequence requires a minimum of mathematical knowledge since the items increase by 4 and 2 by turn.

The series items can be made more difficult by not asking the subjects to continue or complete a sequence but to fill in the missing middle. The example elucidated above can be made more difficult by the following:

Instruction: Write the numbers which will fill the blanks so as to continue with the series.

(B)   7,11,13,17,_,_,31,35

Instruction: Write the choice of the alphabets which will come next in the series.

(C) rscdstdetuef…….

(a) uv (b) vw (c) uw (d) fg (e) wv

Instruction: Write the choice of the number which will replace the question mark in the matrix.

2	4	6
3	6	?
4	8	12

(a) 7 (b) 9 (c) 8 (d) 10 (e) 11

NON-VERBAL SERIES

Instruction: The following question consists of figures called problem figures which are followed by other figures called answer figures. Select the figures from amongst the answer figures which will continue the same series as established by the problem figures.
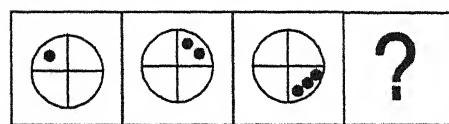
Problem Figures   Answer Figures
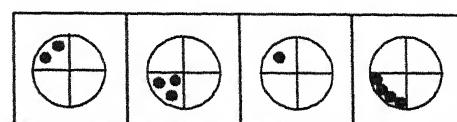
1   2   3   4   A   B   C   D

4.   NUMERICAL ABILITY

It is the facility to manipulate numbers rapidly and accurately. It does not require any great mathematical ability but does require a certain minimal level of arithmetic attainment as numbers cannot be manipulated except by the rules of mathematics.

These items are designed to measure candidate's ability to deal with number concepts, quantity and mathematical symbols. The candidate is required to comprehend the relationship between the numbers and mathematical symbols and apply reasoning to solve the item correctly.

Instruction: If the interchanges are made in signs and numbers, which one of the following equations would be correct?

Interchange: Sign + and ÷ and number 3 and 6.

(a) 3 + 6 ÷ 2 = 4

(b) 6 + 3 ÷ 4 = 2.5

(c) 6 ÷ 3 + 3 = 6

(d) 3 + 6 ÷ 6 = 10

Instruction: In an imaginary mathematical system × means +, ÷ means -, - means × and + means ÷. All other rules in the mathematical operation are the same as in the existing system. Solve the following equation using the new rule.

123 ÷ 42 + 195 - 15 × 70 = ?

(a) 995   (b) 959   (c) 559   (d) 555   (e)   599

71

Instruction: Which one of the four interchanges in signs and numbers would make the given equation correct.

3 + 5 − 2 = 4

(a) + and -, 2 and 3

(b) + and -, 2 and 5

(c) + and -, 3 and 5

(d) none of the above

5.   SPATIAL ABILITY

This is the ability to visualize two or three dimensional figures when their orientation is changed. Items usually consist of a shape followed by a further set of shapes. Subjects are required to say which in the set of shapes is the same as the exemplar turned around. Another item asks subjects to identify from the set of shapes the one which is the same as the first one seen in a mirror or turned over. Spatial ability is often thought to refer to competence in encoding, transforming, generating, and remembering internal representations of objects in space and their relationships to other objects and spatial positions.

EXAMPLE

Instruction: In the following question, choose the correct mirror image of the figure X from amongst the four alternatives (A), (B), (C) and (D) given alongwith it.
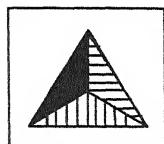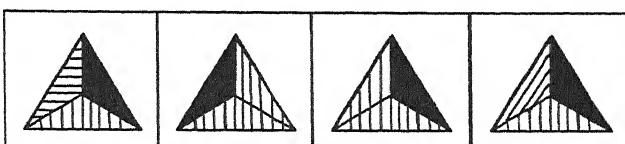
X   A   B   C   D

6. PERCEPTUAL SPEED AND ACCURACY

This type of item involves rapid recognition of perceptual details and the ability to perceive similarities and differences in visual patterns. Items consist of a shape which has to be compared with another shape and marked as or different, or letter or number combinations which have to be compared with other similar combinations.

EXAMPLE

Instruction: The problem figure, P, is hidden in one of the figures shown in the choice figures A, B, C and D. Find that figure (P) and write the correct choice on your answer sheet.

P   A   B   C   D

73
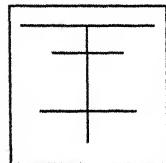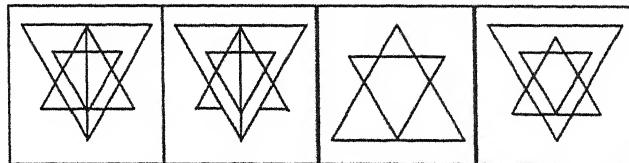
7. MATRICES OR PERCEPTUAL SPEED OF CLOSURE

This involves the ability to complete a shape when parts of it are missing. These items are intended to measure a candidate's ability to comprehend logical relationship of its pattern and its part. The candidate is required to select the appropriate missing part for the completion of each pattern.

EXAMPLE

Instructions: Write the choice of the correct figure which will complete the design.
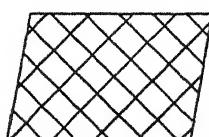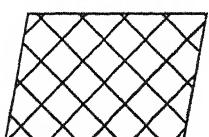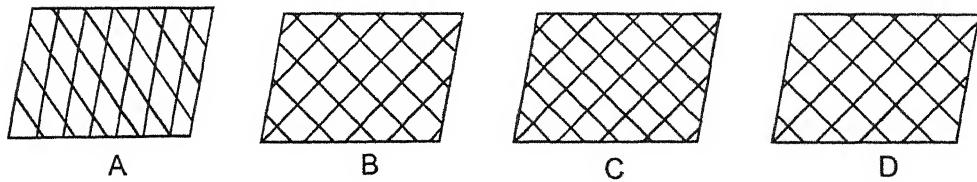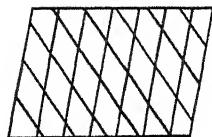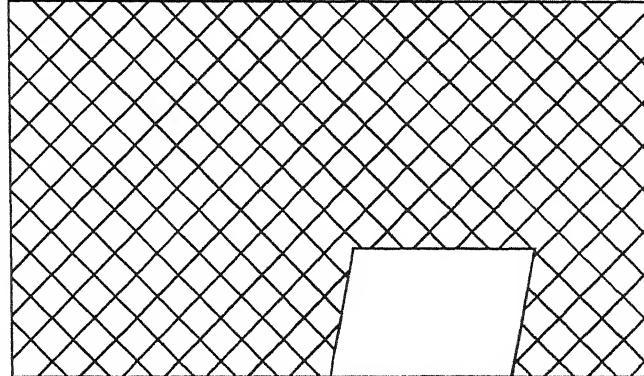
8. INDUCTIVE REASONING

This type of item involves inductive reasoning from the specific to the general. In inductive reasoning, the information contained in the premises of a problem is insufficient to reach a conclusion. As a result, one can reach inductively probable conclusions, but not deductively certain ones.

EXAMPLE

Items on Analogies, Sequences, both verbal and non-verbal are examples of inductive reasoning.

8. DEDUCTIVE REASONING

This type of item involves deductive reasoning from the general to the specific. In deductive reasoning, the information contained in the premises of a problem is logically sufficient to reach a valid conclusion.

EXAMPLE

Instruction: Five friends M,P,Q,N and O are sitting on a bench in the following order-

- O is sitting next to M and P is next to Q

- Q is not sitting with N, N is on the extreme left hand side of the bench and P is on the second position from right hand side

- O is on the right hand side of M and to the right side of N

- O and P are sitting together.

Who is sitting in the middle?

(a) O   (b) Q   (c) M   (d) P   (e) N

9. CODING

These items are designed to measure a candidate's ability to codify an information speedily and correctly. The candidate is required to understand the rule or principle followed in an item and then apply the same logic to solve the problem.

EXAMPLE

(A)   If LUNCH is coded as 58 then DINNER would be coded as ?

(a) 46   (b) 66   (c) 62   (d) 64   (e) 65

(B)   If ROSE is coded as ILHV, PANSY is coded as KZMHB, then LOTUS will be coded as ?

(a) OGLEH   (b) OLGEH   (c) OGLHE   (d) OHGLE   (e) OLGHE

To make the test interesting for the subjects, care was taken to see that more than one item was included in each type of test, that is, series, analogies, and so on. Therefore, the subjects were confronted with the problem of selecting the test-items and presenting them with appropriate response criteria.

WRITING MENTAL ABILITY TEST ITEMS

The following points were considered for writing the mental ability test items-

(a) Language of the items were kept as simple as possible. Each item was preceded by a detailed instruction so that the subject knew exactly what was required by him to do in the item,

(b) Elaborate instructions and examples for each type of the item was provided to the subjects. Each example item was explained and all doubts, if any, were cleared before the actual testing,

(c) All incorrect options (distractors) were kept equally plausible. If the distractors are obviously incorrect, the item is worthless, since all the subjects would choose the correct answer,

(d) Each item had only one correct option. Variability of answers or a different way of looking at the question (a different reasoning for the item) was eliminated by getting the item scrutinized by a panel of judges,

(e) Care was taken to see that the distractors of an item do not answer or make obvious the correct answers to other items,

(f) No distractor or option like 'none of these' or 'all of these' were included in the test.

SCORING PATTERN OF THE MENTAL ABILITY TESTS

Multiple-choice items were used for this mental ability test. Each multiple-choice item had two parts; (a) the stem which contained the question or problem and (b) the options or choice patterns which constituted a set of possible answers, one of which the subject had to select. For all the items in this mental ability test a choice of four/five options were given.

Advantages of using multiple-choice items is that each item is perfectly reliable, the items are easily scored and the problem of guessing is

reduced. The possibility of correct guessing is kept at one in five/four (that is, the number of choice options) provided the distractors are equally attractive.

The examiner usually faces a lot of difficulty in checking the questions which are based on multiple choice and it becomes really difficult to evaluate whether the subject has marked the answer by making use of his prior knowledge and understanding of the subject or merely by guessing it. In any multiple choice question there are four possible outcomes:

R (rights), the questions marked correctly

W (wrong), the questions marked incorrectly

O (omits), the questions that have not been marked but are followed by questions that have been answered either right or wrong. It appears that subject tried to attempt the question and then decided to omit it and move on to the next question.

U (not attempted), the number of questions at the end of the test which are not marked. It seems that subject did not have opportunity to attempt these questions before time was over.

The subject who knows the answer to the question will solve it correctly and mark quickly, therefore, he will have more time to approach the other questions than a subject who does not know the answer. Problem of guessing arises when the subject realizes that he has only a few minutes left and may feel that it is rather beneficial for him to mark quickly the rest of

the answers for which he does not have the time to read and get rewarded. If the final marks are taken as questions marked correctly, this subject is likely to enhance his marks in the last few minutes than another equally good subject who attempted only one question in those few minutes. If omitted and not attempted items are fairly large, the number of questions marked correctly will turn out to be a dependable score for the examination. In such a case a subject would have read each question and honestly tried to solve the questions for he has the fear of negative marks (if any).

Gulliksen (1959) suggested that if a test is a trial run, it may be possible to shorten the test by eliminating some of the items, so that more respondents can finish the test. However, if the test scores must be used and if it is not possible for other reasons to shorten the test or lengthen time then it is possible to consider more complicated scoring procedures to avoid the possible effects of guessing.

The following correction formula should be adopted:

$$S = \frac{R - W}{N-1}$$

Where,   S = pure score for guessing

R = number of correct responses

W = number of wrong responses

N = total number of responses available

For the purpose of this study one mark was awarded for each correct answer and zero for an incorrect answer.

CHAPTER 6

SELECTION OF ITEMS

FORMULATION OF THE INITIAL ITEM BANK

The initial item bank comprising of all the above mentioned types of items consisted of 250 items, of which 120 were of the verbal type and 130 were items measuring different types of non-verbal measures of mental abilities. Table no 1 indicates the types of items in the initial item bank.

TABLE –1

Indicating the different types of items in the initial item bank

VERBAL		NONVERBAL	
Types of items	Number of items	Types of items	Number of items
Analogies	16	Analogies	30
Classification	16	Classification	20
Series	18	Series	20
Numerical Ability	18	Spatial Ability	20
Reasoning	20	Perceptual Speed and Accuracy	20
Verbal comprehension	16	Matrices	20
Coding	16		
TOTAL	**120**	**TOTAL**	**130**

After developing all the different measures of verbal and non-verbal items of the test and determining its item types, it was essential to evaluate the items for the preliminary tryout of the test.

SCRUTINY OF ITEMS BY EXPERTS

The item bank comprising both verbal and non-verbal items were given to a panel of five judges who had previous experience in test construction and specifically development of mental ability tests. The judges were asked to scrutinize each item on the following parameters for inclusion of each item in the test. The judges were informed about the age, education and other important details about the target group so that improvements could be made based on their suggestions. The criterion were, namely,

(i) to judge each item on its relevance to testing mental ability of children of 12-17 years of age,

(ii) to classify each item on the type of mental ability it was measuring, i.e., series, analogies, and so on,

(iii) each item should be followed by four/five choices and the choices (answer and the distractors) should be such that the distractors were not too different from the answer,

(iv) each item should have only one logic to act as an answer,

(v) each item should have only one answer, and

(vi) the language of the items, that is, clarity of words should be such that it should be easily understood by everyone.

The item bank was analyzed based on the scrutiny of the judges. Some items were modified to the agreement of all the judges while a few were deleted either because they were found to be too easy or too difficult or did not meet the criteria for inclusion of an item in the test as mentioned above. The modified item bank or the preliminary form of the tests included 100 items each of the verbal and non-verbal types. The distribution of the types of items in both the verbal and non-verbal tests was as shown in Table no. 2.

TABLE –2

Indicating the different types of items in the preliminary test form

VERBAL   NONVERBAL

Types of items	Number of items	Types of items	Number of items
Analogies	15	Analogies	25
Classification	15	Classification	20
Series	14	Series	20
Numerical Ability	16	Spatial Ability	10
Reasoning	10	Perceptual Speed and Accuracy	05
Verbal comprehension	15	Matrices	20
Coding	15		
TOTAL	**100**	**TOTAL**	**100**

Care was taken to write the instructions which were divided into two parts: (a) ordinary instructions, the form of the test and the description of the objectives, and (b) detailed special instructions relating to the test and each type of item contained in the test. Wording of the instructions were kept clear and understandable. The usefulness of the instructions were checked by solving the practice items which the subject had to solve in the final real test.

In the preliminary form of the test there are usually double the number of items than there are in its final form and these are gradually arranged from simple to more difficult ones. Therefore, at this stage, the following points were considered:

(a) To develop the test items for the different types, that is, series, analogies, etc.

(b) To include the various forms of the items, that is, both verbal and non-verbal.

(c) Review, modify and edit the items as per the recommendations of the specialists.

(d) To write down the instructions separately for the main test and each type of item being used in the test.

(e) To determine the mode of value assessment in such a way that similar items are arranged or presented together for convenience of assessment and interpretation along with providing convenience to the subjects in the target group.

After the construction of the test and its pre-tryout form, an effort was made to evaluate the test for its quality, validity and reliability and to delete the unnecessary items. Therefore, prior to the construction of final form it is essential to test the pre-tryout form. This is done for the following purposes:

(i) By this check, the weak and erroneous items, those with double meanings, uncertain items, inadequate items, (those with incomplete meaning), very difficult and very simple items get deleted from the test.

(ii) The test objectives gets reflected in all the selected items in order to ensure the validity of every individual item.

(iii) To indicate the actual number of items included in the final form of the test.

(iv) To express or bring out the shortcomings of the responses of the subjects and the examiner.

(v) To determine the inter-item correlations and thus, prevent overlap in item content.

(vi) To arrange all the items of the test as per the types of items used.

(vii) To determine the test instructions, related precautions and groups to be affected etc.

(viii) To know the actual limit of the final form of the test.

(ix) To determine the value-assessment of the test.

Under the above mentioned steps, the evaluation of the test was divided into two parts.

(i) the first evaluation was known as the pre-tryout and its objective was to find out the main shortcomings of the test and remove them, and,

(ii) the second evaluation, known as actual tryout, related to a very important aspect of the test, i.e., item-analysis.

PRE-TRYOUT

For the pre-tryout, the test was administered on 50 subjects with the objective of finding out the main shortcomings of the test and remove them. Thus, the test was administered on a small representative group of the actual target group by which many aspects related to the test were estimated and main short comings were removed. However, this test administration did not allow any individual item-analysis. The time to be taken for the administration of the test in the preliminary try out was also determined. The instructions of the test were also analyzed to see whether they were easily and clearly understood by the subjects. At the same time, the scoring process which is easy or familiar was also used.

ACTUAL TRYOUT

Under the actual tryout of the test, the technical process of item analysis is used. In this context, Guilford (1954) observed, "The main objective of the second administration of the test, or actual tryout is item-analysis, in which the number of subjects should be about 400. Then the validity and difficulty level of each item of the test is determined and accordingly some items are included and some are excluded from it."

Both the verbal and the non-verbal tests of mental ability used in the actual tryout are given in Appendix I and II respectively.

CHAPTER 7

ITEM ANALYSIS

ITEM ANALYSIS

The effectiveness and usefulness of any test depends upon the qualities of the items that are included in it. The score of the test is obtained as a result of its reliability, validity and the inter correlations between two items. Hence, to make the test more effective, one by one all the items which are included in it should be carefully studied. This process is known as item analysis. In other words, in this method of item analysis, all the items of the test are studied individually to see as to what number of persons of a group or percentage has actually tried to respond or solve each item. Under this method, the usefulness of the item is analyzed because the quality and utility of the test depends on those items which finally comprise the test. So in the process of test construction, the item analysis is quite necessary for the selection of items for the final test form which will be according to the objectives and subject matter of the test. According to Guilford (1954) 'before the construction of the final test form, for the selection of the best items, the use of item analysis is most appropriate'.

Item analysis would be treated under three heads, namely, (i) item selection, (ii) item difficulty, and (iii) item validity.

Item selection: the choice of an item depends, in the first instance, upon the judgment of competent persons or specialists for the purpose of the test. This is the 'content validity' of the test items (Garrett & Woodworth, 1981). Certain types of items have proved to be generally useful in intelligence and mental ability testing. Problems in numerical ability, vocabulary, analogies, number series completion, for example, are found over and over again, so also are items requiring generalization, interpretation, and the ability to see relations. The validity of the items in most tests depends upon the consensus of experts or specialists on the adequacy of the items used for measuring a particular construct. As mentioned earlier the item bank of 250 verbal and non-verbal items were given to experts and based on their judgment 200 items for which there was total conformity between the judges was finally selected for the actual tryout.

Item Difficulty: The difficulty of an item can be determined in several ways, firstly, by the judgment of competent people who rank items in order of difficulty, secondly, by how quickly the item can be solved, and thirdly, by the number of examinees in the group who solve the item correctly. The first two procedures are usually a first step, especially when the items are for use in special aptitude tests, in performance tests, and in areas where qualitative distinctions and opinions must serve as a criteria. But the number right or the proportion of the group which can solve an item correctly, is the

'standard' method for determining difficulty in objective examinations. This is the statistical as contrasted with the judgmental approach to item validity.

(a) index of item difficulty. If 90% of a standard group pass an item, it is easy; if only 10% pass, the item is hard. When p = the percentage passing an item and q = the percentage failing, the SD of the item, that is, its variability is pq and its variance is pq. When p = .50 and q = .50, the item variance is .25. This is the maximum variance which an item can have; hence an item with a difficulty index of .50 (p = .50) brings out more individual differences than a hard or easy item. In general, as p drops below .50 or goes above .50, the variance of the item steadily decreases. Other things being equal, items of moderate difficulty (40-50-60% passing) are to be preferred to those which are much easy or much hard. Difficulty level helps in arranging the items in order. This indicates which item will come first, in the middle or at the end or in any other position.

For the purpose of this study, the difficulty level of the items was computed by making use of the items responded percentage. All the items which fell within the difficulty range of .30 to .70 were accepted for this study. A difficulty index of .70 would mean that that particular item is the most easy of all the items comprising the test and should be the first item in the actual or final form of the mental ability test. The item difficulty of .30 would mean that that particular item is the

most difficult item in the test and should be placed at the end o

test when placing the items in a graded difficulty level.

(b) Item inter-correlations and range of difficulty: In item selec

not only must individual item difficulty be considered, but

inter- correlations of the items of the test as well. It is ha

feasible to compute all the item inter-correlations. If the items

test all correlate +1.00, then a single item will do the work of

At the other extreme, if all item correlations are .00, the m

score of every subject will tend to be about ½ of the total num

of items. In mental ability tests, the inter-correlations among ite

are usually positive and fairly high, items close together in

scale correlate higher than items far apart.

Item Validity or Item Discrimination: The validity index of an item,

is, its discriminative power, is determined by the extent to which the gi

item discriminates among subjects who differ sharply in the function

functions) measured by the test as a whole. Though a number of meth

are available for determining the discriminative power of an item,

biserial correlation was used for the purpose of this study. The bise

correlation was used to give the correlation of an item with the total scor

on the mental ability tests separately for the verbal and the non-verbal

tests.

The extreme group comparisons were done for determining the validity indices for each of the items of the tests. The following procedure was adopted for determining the validity indices and the same procedure was followed twice, once for the verbal test and next for the non-verbal test.

a. Both the verbal and non-verbal tests were administered on 200 subjects and the responses of these 200 subjects on each of the 100 verbal and 100 non-verbal items were taken for determining the validity indices of each of the items.

b. The answer sheets for both the verbal and the non-verbal were arranged in order of size with the answer sheet of the subject scoring the highest marks being kept on the top and the subject scoring the least marks was kept at the bottom.

c. The top 27% and the bottom 27% of the answer sheets were used for the analysis. That is, 54 answer sheets of the 'top' group and 54 answer sheets of the 'bottom' group.

d. The middle 92 answer sheets were not used for the analysis and were used simply to mark off the two end groups.

e. The responses of each subject to each item was used to mark the tally of the number in the 'top' group which passed each item on the test and similarly the procedure was repeated to mark the tally for the 'bottom' group.

f. These tally numbers were converted to percentages for both the 'top' and the 'bottom' groups.

g. The percents for both 'top' and 'bottom' groups were corrected for chance success.

h. The percent of success of both the 'top' and 'bottom' groups were superimposed on the Flanagan's table of normalized biserial correlations and the biserial correlation, that is, item validity or item discrimination was computed.

i. On averaging the percentage of success of 'top' group and 'bottom' group the item difficulty index of each item was computed.

Both the difficulty index and discriminative index for each of the items of the verbal and non-verbal tests were computed using the above procedure and is reflected in Appendix III and IV.

For the purpose of this study all the items which had a discriminative index of .20 and above were retained in the final forms of both the mental ability tests, both verbal and non-verbal. Keeping the range of difficulty indices between .30 to .70 and the discriminative index .20 and beyond, 40 items were retained for the final form of the verbal mental ability test. In a similar manner 40 items were retained in the final form of the non-verbal mental ability test. The types of items retained for the final forms of both the verbal and the non-verbal tests are shown in Table- 3. The items for both the verbal and non-verbal tests were arranged in the graded difficulty level from the most easy to the most difficult one and is shown in Appendix V and VI respectively. The final forms of both the verbal and non-verbal ability tests are shown in Appendix VII and VIII respectively.

TABLE –3

Indicating the different types of items retained in the mental ability tests

both before and after item analysis (N=200)

VERBAL   **NONVERBAL**

Types of items	Number of items before item analysis	Number of items after item analysis	Types of items	Number of items before item analysis	Number of items after item analysis
Analogies	15	03	Analogies	25	12
Classification	15	03	Classification	20	04
Series	14	06	Series	20	05
Numerical Ability	16	06	Spatial Ability	10	04
Reasoning	10	07	Perceptual Speed and Accuracy	05	06
Verbal comprehension	15	09	Matrices	20	09
Coding	15	06			
TOTAL	100	**40**	TOTAL	100	**40**

Fixation of optimum time limit is another important aspect of test construction. The final forms of both the verbal and non-verbal mental ability tests were administered to 200 school children of 15-17 years for fixing up the optimum time limit for both the tests. The following procedure was undertaken for time fixation:

a. The verbal mental ability test was administered on 200 subjects under three different timings, namely, 15 minutes, 20 minutes and 25 minutes.

b. The non-verbal mental ability test was also administered on 200 subjects under three different timings, namely, 15 minutes, 20 minutes and 25 minutes.

c. Responses of the subjects under the three different timings for both the tests were scored. That is, three sets of data each for the verbal test and the non-verbal tests were prepared.

d. Statistical analysis for each of the three sets of data was done to test the parameters of time fixation.

    Parameters of time fixation: the parameters used for fixing up the optimum time limit were as under:

(a) mean of the scores should be close to the middle of the scale, which in this case would be around 20 as the test consisted of 40 items,

(b) Variance should be high,

(c) Skewness, B1, should be close to zero,

(d) Kurtosis , B2, should be close to three, and

(e) Reliability of the test should be high.

The statistics of time fixation are shown in Table 4 and Table 5.

TABLE 4

Indicating the statistics used for different timings of the verbal test

(N=200)

Timings	Mean	Variance	Skewness	Kurtosis	Reliability
15 minutes	16.70	36.34	.11	2.76	.80
20 minutes	19.38	49.23	.04	2.95	.84
25 minutes	21.73	40.76	.08	3.49	.81

As can be seen from Table 4 most of the parameters for time fixation were met when the test was administered with a timing of 20 minutes. The mean of the responses was 19.38 which was the nearest to the true mean of 20.00. The variance was the highest in comparison to the statistic arrived at from the two other timings. Skewness at .04 depicts that the distribution of

the response scores was more towards the normal probability curve. Kurtosis, or peakedness of the curve at 2.95 resembled the normal curve and the reliability index of .84 was the highest as compared to the indices arrived at from the other two timings.

TABLE 5

Indicating the statistics used for different timings of the non-verbal

test (N=200)

Timings	Mean	Variance	Skewness	Kurtosis	Reliability
15 minutes	17.16	39.98	.09	2.61	.82
20 minutes	20.07	45.36	.03	2.37	.85
25 minutes	21.93	46.82	.18	2.05	.85

The final timings fixed for the verbal mental ability test and that of the non-verbal mental ability test are shown in Table 6.

TABLE 6

Indicating the time limit of Mental Ability Tests both verbal and non-verbal (N=200)

SI No.	Name of the Test	Time limit (in minutes)
1	Mental ability test –verbal	20
2	Mental ability test -non-verbal	20

97

CHAPTER 8

RELIABILITY, VALIDITY& NORMS

RELIABILITY OF THE TEST

Reliability refers to the consistency of scores obtained by the same persons when reexamined with the same test on different occasions, or with different sets of equivalent items, or under other variable examining conditions. This concept of reliability underlies the computation of the error of measurement of a single score, whereby the prediction of the range of fluctuation likely to occur in a single individual's score can be made as a result of irrelevant and chance factors (Anastasi,1988).

The concept of test reliability has been used to cover several aspects of score consistency. In its broadest sense, test reliability indicates the extent to which individual differences in test scores are attributable to 'true' differences in the characteristics under consideration and the extent to which they are attributable to chance errors. In more technical terms, measures of test reliability make it possible to estimate what proportion of the total variance of test scores is the error variance. Essentially, any condition that is irrelevant to the purpose of the

test represents error variance. Error variance can be reduced by maintaining uniform testing conditions by controlling the testing environment, instructions, time limits, rapport, and other similar factors by the examiners and making the test scores more reliable. Despite optimum testing conditions, however, no test is a perfectly reliable instrument. Hence, every test must be accompanied by a statement of its reliability. Such a measure of reliability characterizes the test when administered under standard conditions and given to persons similar to those constituting the normative sample. The characteristics of this sample should therefore be specified, together with the type of reliability that was measured (Anastasi, 1988).

Since all types of reliability are concerned with the degree of consistency or agreement between two independently derived sets of scores, they are expressed in terms of correlation coefficient.

There are various methods which can be employed to find out the reliability of the test. For the purpose of computing the reliability of this particular test under construction, the Kuder-Richardson Method was used. This method utilizes a single administration of a single form and is based on the consistency of responses to all the items in the test. This *inter item consistency* is influenced by two sources of error variance: (1) content sampling; and (2) heterogeneity of the behaviour domain sampled. The more homogeneous the domain, the higher the inter item consistency. For ex, if one test includes only multiplication items, while another comprises addition, subtraction, multiplication, and division items, the former test will probably show more inter item consistency than the

latter. It is apparent that test scores will be less ambiguous when derived from relatively homogeneous tests.

A highly relevant question in this connection is whether the criterion that the test is trying to predict is itself relatively homogeneous or heterogeneous. Although homogeneous tests are to be preferred because their scores permit fairly unambiguous interpretation, a single homogeneous test is obviously not an adequate predictor of a highly heterogeneous criterion. Moreover, in the prediction of a heterogeneous criterion, the heterogeneity of test items would not necessarily represent error variance. Traditional intelligence and mental ability tests provide a good example of heterogeneous tests designed to predict heterogeneous criteria, in such a case, it may be desirable to construct several relatively homogeneous tests, each measuring a different phase of the heterogeneous criterion. Thus, unambiguous interpretation of test scores could be combined with adequate criterion coverage.

The most common procedure for finding inter item consistency is that developed by Kuder and Richardson (1937). It is found by a single administration of a single test. Rather than requiring two half-scores, however, this technique is based on an examination of performance of each item. The most widely applicable, commonly known as "Kuder-Richardson formula 20", is the following:

Reliability $(r_{1i})= \dfrac{n}{(n-1)} \times \dfrac{\sigma^2 t - \Sigma pq}{\sigma^2}$

■■

In this formula, r_{1i} is the reliability coefficient of the whole test, n is the number of items in the test, σ, the standard deviation of total scores on the test, p the proportion of the group answering a test item correctly, and q is (1-p) the proportion of the group answering a test item incorrectly. It can be shown mathematically that the Kuder-Richardson reliability coefficient is actually the mean of all split-half coefficients resulting from different splittings of a test (Cronbach, 1951). The Kuder-Richardson formula is applicable to tests whose items are scored as right or wrong, or according to some other all-or-none system.

An important factor influencing the size of a reliability coefficient is the nature of the group on which reliability is measured. In the first place, any correlation coefficient is affected by the range of individual differences in the group. The reliability indices of the verbal and non-verbal mental ability tests are shown in Table7.

TABLE 7

Showing reliability index of verbal and non-verbal mental ability test

(N=200)

SI No	NAME OF THE TEST	RELIABILITY
01	Mental Ability Test-Verbal	.84
02	Mental Ability Test-Non-verbal	.85

VALIDITY OF THE TEST

The validity of a test concerns what the test measures and how well it does so. It tells us what can be inferred from test scores. Test names provide short, convenient labels for identification purposes only. The trait measured by a given test can be defined only through an examination of the objective sources of information and empirical operations utilized in establishing its validity (Anastasi, 1950). Moreover, the validity of a test cannot be reported in general terms. No test can be said to have 'high' or 'low' validity in the abstract. Its validity must be established with reference to the particular use for which the test is being considered.

Fundamentally, all procedures for determining test validity are concerned with the relationships between performance on the test and other independently observable facts about the behaviour characteristics under consideration. The specific methods employed for investigating these relationships are numerous and have been described by various names. In the Standards for Educational and Psychological Tests (1974), these procedures are classified under three principal categories: content, criterion-related, and construct validity (Anastasi,1982).

Content validation involves essentially the systematic examination of the test content to determine whether it covers a representative sample of the behaviour domain to be measured. Such a validation procedure is commonly used in evaluating achievement tests. This type of test is designed to measure how well the individual has mastered a specific skill or course of study. It might seem that mere inspection of the content of the test should suffice to establish its validity for such a purpose. A test of multiplication, spelling, or bookkeeping would seem to be valid by definition if it consists of multiplication, spelling, or housekeeping items, respectively.

Criterion-related validation procedures indicate the effectiveness of a test in predicting an individual's behaviour in specified situations. For this purpose, performance on the test is checked against a criterion, i.e., a direct and independent measure of that which the test is designed to predict. Thus, for a mechanical aptitude test, the criterion might be subsequent job performance as a machinist and for a scholastic aptitude test, it might be college grades. The criterion measure against which test scores are validated may be obtained at approximately the same time as the test scores or after a stated interval. The APA Test Standards (1974) differentiate between concurrent and predictive validity on the basis of the time relations between criterion and test. The term "prediction" can be used in the broader sense, to refer to prediction from the test to any criterion situation, or in the more limited sense of prediction over a time interval. It is the latter sense that is used in the expression 'predictive validity.' The information provided by predictive validation is most relevant to tests used in the selection and classification of personnel. In a number of

instances, concurrent validation is employed merely as a substitute for predictive validation. It is frequently impracticable to extend validation procedures over the time required for predictive validation or to obtain a suitable preselection sample for testing purposes (Anastasi, 1988) Tests are therefore administered to a group on whom criterion data are already available. Thus, the test scores of school students may be compared with their scholastic achievement scores at the time of testing or those of employees compared with their success on current job.

Correlations between a new test and previously available tests are frequently cited as evidence of validity. When the new test is an abbreviated or simplified form of a currently available test, the latter can properly be regarded as a criterion measure. Thus, a paper-pencil test might be validated against a more elaborate and time consuming performance test whose validity had previously been established. Or a group test might be validated against an individual test. These correlations should be moderately high, but not too high. If the new test correlates too highly with an already available test, without such added advantages as brevity or ease of administration, then the new test represents needless duplication.

The construct validity of a test is the extent to which the test may be said to measure a theoretical construct or trait. Examples of such constructs are intelligence, mechanical comprehension, verbal fluency, neuroticism and anxiety. Each construct is developed to explain and organize observed response consistencies. It derives from established interrelationships among

behavioral measures (Cronbach & Meehl, 1955; Messick, 1975,1980a). Construct validation requires the gradual accumulation of information from a variety of sources. Any data throwing light on the nature of the trait under consideration and the conditions affecting its development and manifestations are important for its validation.

A validity coefficient is a correlation between test score and criterion measure. Because it provides a single numerical index of test validity, it is commonly used in test manuals to report the validity of a test against each criterion for which the data is available. The data used in computing any validity coefficient can also be expressed in the form of an expectancy table or expectancy chart which gives the probability that an individual who obtains a certain score on the test will attain a specified level of criterion performance. As in the case of reliability, it is essential to specify the nature of the group on which a validity coefficient is found. The same test may measure different functions when given to individuals who differ in age, sex, educational level, occupation, or any other relevant characteristic. Persons with different experiential backgrounds, for example, may utilize different work methods to solve the same test problem.

The question of sample heterogeneity is relevant to the measurement of validity, as it is to the measurement of reliability, since both characteristics are commonly reported in terms of correlation coefficients. Other things being equal, the wider the range of scores, the higher will be the correlation.

VALIDITY CRITERION

Responses of 100 subjects on Raven's Standard Progressive Matrices (SPM) Sets A,B,C,D and E (Raven, 1960) were used as the validity criterion for this new mental ability test. The academic performance of this sample in the previous annual school examination was also taken as an index for establishing validity. The scores of this sample on the newly developed mental ability tests, verbal and non-verbal were correlated with both the scores on the SPM and the academic performance.

Standard Progressive Matrices is a test suitable for comparing people with respect to their immediate capacities for observation and clear thinking. The SPMs sets A,B,C,D and E is a test of a person's capacity at the time of the test to apprehend meaningless figures presented for his observation, see the relations between them, conceive the nature of the figure completing each system of relations presented, and, by so doing, develop a systematic method of reasoning. The SPM consists of 60 problems divided into five sets of 12. In each set the first problem is as nearly as possible self-evident. The problems which follow become progressively more difficult. The order of the tests provides the standard training in the method of working. The five sets provide five opportunities for grasping the method and five progressive assessments of

a person's capacity for intellectual activity. To ensure sustained interest and freedom from fatigue, the figures in each problem are boldly presented, accurately drawn and, as far as possible, pleasing to look at. The scale is intended to cover the whole range of intellectual development from the time a child is able to grasp the idea of finding a missing piece to complete a pattern, and to be sufficiently long to assess a person's maximum capacity to form comparisons and reason by analogy without being unduly exhausting or unwieldy.

Everyone, whatever his age, is given exactly the same series of problems in the same order and is asked to work at his own speed, without interruption, from the beginning to the end of the scale. A person's total score provides an index of his intellectual capacity, whatever his education. The contribution which each of the five sets makes to the total provides a means of assessing the consistency of the estimate and the psychological significance of discrepancies in the test results. The scale has a re-test reliability varying with age from 0.83 to 0.93 and has a 'g' saturation of 0.82.

The scores of the sample on mental ability tests, verbal and non-verbal were correlated with the scores achieved on the SPM. The validity indices of the verbal and non-verbal mental ability tests are shown in Table 8.

TABLE 8

Showing validity index of verbal and non-verbal mental ability test with SPM (N=100)

SI No	NAME OF THE TEST	VALIDITY WITH SPM
01	Mental Ability Test-Verbal	.61
02	Mental Ability Test-Non-verbal	.73

The scores of the sample on mental ability tests, verbal and non-verbal were also correlated with their academic performance. The validity indices of the verbal and non-verbal mental ability tests when compared with academic performance are shown in Table 9.

TABLE 9

Showing validity index of verbal and non-verbal mental ability test with academic performance (N=100)

SI No	NAME OF THE TEST	VALIDITY INDEX
01	Mental Ability Test-Verbal	.47
02	Mental Ability Test-Non-verbal	.35

The above tables (Table 8 & 9) show that the validity indices of both the verbal and non-verbal mental ability tests are highly significant when SPM is used as the validity criterion. The correlation is more significant for non-verbal mental ability test as the criterion used also consisted of non-verbal stimuli. The verbal mental ability test also correlated significantly with the SPM which highlights the fact that both measure similar construct, that is, reasoning in this case. The poor correlation of the mental ability tests with academic performance reiterates the fact that the two measure different constructs. The school curriculum and the way it is assessed did lead to a moderate correlation with the verbal intelligence test maybe because the item types on verbal comprehension and numerical ability were similar to what is taught in school.

DEVELOPMENT OF NORMS

Scores on psychological tests are most commonly interpreted by reference to norms which represent the test performance of the standardization sample. The norms are thus empirically established by determining what the persons in a representative group actually do on the test. Any individual's raw score is then referred to the distribution of scores obtained by the standardization sample, to discover where he or she falls in that distribution. In order to determine more precisely the individual's exact position with reference to the standardization sample, the raw score is converted into some relative measure. These derived scores are designed to serve a dual purpose. First, they indicate the individual's relative standing in the normative sample and thus permit an evaluation of her or his performance in reference to other persons. Second,

109

they provide comparable measures that permit a direct comparison of the individual's performance on different tests. Derived scores, on the other hand, can be expressed in the same units and referred to the same or to closely similar normative samples for different tests. The individual's relative performance in many different functions can thus be compared.

There are various ways in which raw scores may be converted to fulfill the two objectives stated above. Fundamentally, however, derived scores are expressed in one of two major ways: (1) developmental level attained; (2) relative position within a specified group (Anastasi, 1988).

Nearly all standardized tests provide some form of within-group norms. With such norms, the individual's performance is evaluated in terms of the performance of the most nearly comparable standardization group, as when comparing a child's raw score with that of children of the same chronological age or in the same school grade. Within-group scores have a uniform and clearly defined quantitative meaning. Most psychological tests are making increasing use of standard scores which express the individuals distance from the mean in terms of standard deviation of the distribution. The mean is taken as the zero point, and the standard scores are given as plus or minus. If the distribution of scores of two or more tests are approximately normal, standard scores derived from the distribution may be compared with those derived from the others.

Linearly derived standard scores are often designated simply as 'standard scores' or 'z scores.' For the development of norms both the verbal and non-verbal mental ability tests were administered on 100 school children of the age group 15-17 years. The mean and standard deviations for both the mental ability tests were calculated. Norms were prepared by converting the raw scores of both the verbal and non-verbal mental ability tests to standard scores (equivalent scores).

The formula used for the computation of standard score was as follows:

$$\frac{X' - M'}{\sigma'} = \frac{X \quad M}{\sigma}$$

or $\quad X' = \frac{\sigma'}{\sigma} (X-M) + M'$

Where,

X′ = a standard score in the new distribution (converted score)

X = a score in the original distribution (raw score)

M = mean of the raw score distribution of each test

M′ = mean of the standard score distribution

σ = SD's of raw score distribution of each of the test

σ′ = SD's of standard scores.

A mean of 50 and standard deviation of 10 were used for converting the raw score for both the verbal and non-verbal mental ability tests. The summed equivalent score were divided into five point norms, namely, well above

average intelligence; above average intelligence; average intelligence; below average intelligence and well below average intelligence.

The procedure adopted was as follows-

The base line of the normal curve (6 SD) was divided into five equal parts.

-3σ   -1.80σ   -.60σ   +.60σ   +1.80σ   +3σ
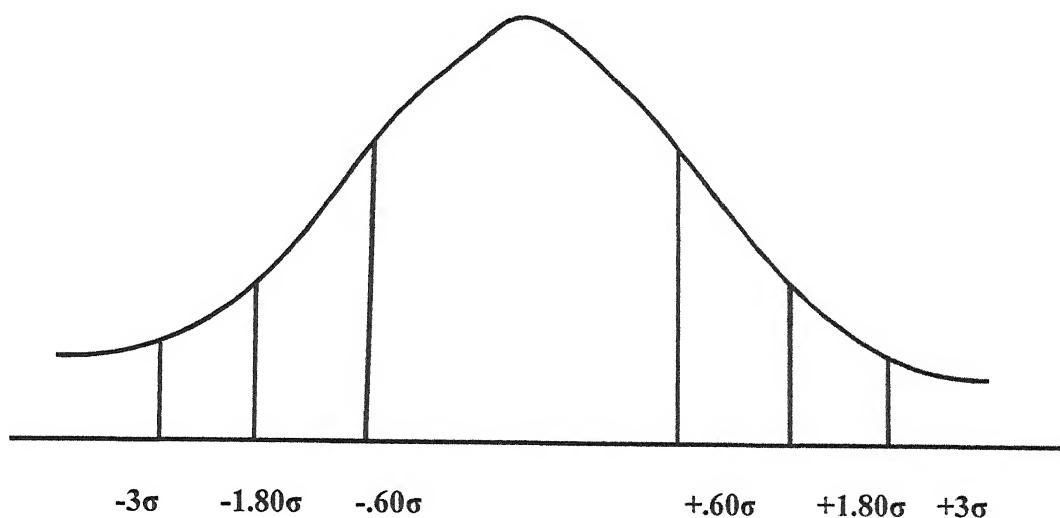
Well above average intelligence corresponds to the line above +1.80, above average intelligence corresponds to the line +.60 to +1.80, average intelligence corresponds to -.60 to +.60, below average intelligence corresponds to –1.80 to -.60 and well below average intelligence corresponds to below –1.80.

The corresponding areas from and or to each of the point limits were obtained from the probabilities integral tables and are:

P1 = .0359

P2 = .2743

P3 = .7257

P4 = .9641

By applying these proportions to the frequency distribution of the combined converted score of the standard scores of both the verbal and non-verbal mental ability tests and by using cumulative frequencies, the corresponding limits or points of the norms were prepared. The norms were obtained on the assumption that the ability measured by the test is normally distributed. The formula used was:

$$PI = LI + \frac{PI\ NI - cf}{F} c_i,$$

Where,

L = exact lower limit of the class interval upon which the given proportion lies

p = the proportion in the normalized scale

N = total number of scores / frequency

cf = sum of the scores on all the intervals below

f = frequency/number of scores within the interval upon which the given proportion falls

c_i = length of the class interval.

The table showing the raw scores and standard (converted) scores of verbal mental ability test is shown in Appendix IX and that of non-verbal mental ability test is shown in Appendix X.

The norms for the age group of 15-17 (as that was the sample taken for the development of norms) is shown in Appendix XI. Any norm, however

expressed, is restricted to the particular normative population from which it was derived. Psychological test norms are in no sense absolute, universal, or permanent. They merely represent the test performance of the persons constituting the standardization sample. For the purpose of this research the norms were expressed in terms of the sample's age and are known as age norms.

CHAPTER 9

SUMMARY

Introduction

Psychological tests have been devised and are used primarily for determination and analysis of individual differences in general intelligence, specific aptitudes, educational achievement, vocational fitness and non-intellectual personality traits. Individual differences in human behavior are always an object of human enquiry ever since the time of human nature. First example of systematic proficiency and achievement 'testing' are reported from ancient Chinese Mandarin civil servant selection procedures (Dubois, 1966).

Intelligence has been defined in many ways by many psychologists as : innate, general cognitive ability (Cyril Burt, 1955); the ability to carry on abstract thinking (Lewis Terman, 1925); general ability (Spearman, 1904); aggregate or global capacity to think rationally, act purposefully and deal effectively with the environment, (Wechsler, 1958); ability to understand complex ideas, to adapt effectively to the environment, to

115

learn from experience, to engage in various forms of reasoning and to overcome obstacles by careful thought (Neisser et al., 1996). Intelligence can also be defined as a group of complex mental processes as sensation, perception, association, memory, imagination, discrimination, judgment and reasoning (Cattell, 1971, Guilford, 1967; Gardner, 1984, 1993, Sternberg, 1997).

The empirical studies of people's notion of intelligence document that in many western countries/ societies there is extreme emphasis on the development of technological intelligence (for example, attention, observation, speed of learning, school intelligence and manual dexterity) (Mundy-Castle, 1974). Vygotsky (1978) argued that the roots of intellectual processes and skills are situated in the socio-cultural matrix of the people in a society during a given socio-historical period. In India, intelligence was conceptualized in terms of socio-affective regulation of one's conduct (Srivastava & Mishra, 2001). Robert Sternberg (1997) proposed a definition of intelligence as comprising the mental abilities necessary for adaptation to, as well as, selection and shaping of any environmental context. Although the mental processes are common across environmental contexts, people's ability, motivation, or decision to apply these processes across contexts may not be equal. Sternberg says that a distinction between intelligence and intelligent behavior is important because there has been so much confusion in the literature on intelligence regarding contextual generality versus specificity of intelligence.

116

Understanding of intelligence, according to Butterworth (1994) requires referring to the internal representation of knowledge, external or contextual factors, and the behavioral expressions of intelligence. In many of the South Asian, African and Latin American cultures, a marked "social" or relational orientation is prevalent in which harmony with nature and co-existence are emphasized (Srivastava, A.K. and Misra, G., 2001). In China, intelligence is seen as constituted of three factors:- non-verbal reasoning ability, verbal reasoning ability and rote memory (Chen, 1994). The Japanese notion of intelligence emphasizes social competence, task efficiency, originality and reading and writing (Azuma and Kashiwagi, 1987). The meaning of the notion of 'intelligence' as understood and used by the lay people in India revealed four major dimensions: cognitive competence, social competence, competence in action, and emotional competence (Srivastava, A.K.& Misra, G. 2001). The contemporary Indian view, thus, places intelligence in the matrix of a practical and social life. It encompasses sociality, emotionality and task orientation in addition to the traditional cognitive abilities.

The conception of intelligence which was once limited to the cognitive domain is now being examined at its interface with other constructs and domains such as creativity (Sternberg & Lubart, 1996), wisdom (Sternberg, 1990; Taskahashi & Bordia, 2000); Wink & Helson, 1997), social intelligence (Cantor & Harlow, 1994), emotional intelligence

(Mayer & Salovey, 1997) and practical intelligence (Sternberg et al. 1995).

History of Intelligence Testing

The development of psychological testing and assessment started in 1882 with the work of Sir Francis Galton in Great Britain and two pioneer studies in individual differences by James McKeen Cattell in 1890, in United States. During the last decade of the 19th century many prototypes of what later were to become mental tests were published for the study of individual differences in memory performance, in reasoning and speed of perception. Ebbinghaus's (1897) work on human memory was a significant contribution in the field of experimental psychology.

In 1895 the French psychologist and lawyer Alfred Binet together with Victor Henri, published a series of short tests designed to measure level of intelligence of children for guidance in educational placement and counseling. Later, the book titled "Psychology of Individual Differences" by a German psychologist William Stern (1900, 1911) laid a conceptual and methodological foundation for the development of psychological assessment .The study of intelligence and its measurement is very fascinating in psychological research. In fact, " intelligence " is the most popular concept in the field of psychology. The history of the studies on intelligence can be traced back to the work of Binet in France and intelligence testing in European and American schools and then its frequent use in industrial, organizational, clinical and work psychology

118

world wide (Eysenck & Eysenck,1985, Spearman, 1904; Burt, 1955; Cattell, 1965; Wechsler, 1958; Pawlik, 1968, 1998; Ree & Careetta, 2002). The role of mental ability in predicting work performance is well documented (Guttfredson, 2002; Salgado & Anderson, 2002; Kehoe, 2002; Tenopyr, 2002).

The historical and developmental status of intelligence testing can be classified into three categories (Daniel,1997):

(1) Test of Psychometric Abilities

It refers to abilities that have been identified through factor analysis of sets of diverse cognitive tasks (for example, verbal and spatial abilities, inductive reasoning, and memory). Intelligence batteries in this category tend to be interpreted with respect to a model of the structure of abilities that itself is based on finding from factor analysis. Some of these type of tests are: Wechsler's Intelligence test for Children (Wechsler, 1991) which offers four factors-verbal comprehension, perceptual organisation, processing speed and freedom from distractibility; Fourth edition of Stanford-Binet intelligence scale (Thorndike, Hagen & Sattler, 1986) which measures crystallized intelligence-visual reasoning, and short term memory; the Kaufman Adolescent and Adult Intelligence Test (Kaufman & Kaufman, 1993) which focuses on fluid and crystallized while assuring immediate and intermediate-term memory, where as the Woodcock-Johnson Tests of Cognitive Ability-Revised (Woodcock & Johnson, 1989); DAT Scales (Elliot, 1990), which emphasize on a differentiated view of intelligence through the measurement of six ability

dimensions. However, the shift toward a multifactor model of intelligence has not been accompanied by a general rejection of the concept of g. Knowledge of the educational and vocational applications of the broad abilities at the level below g are surprisingly limited.

(2)   Tests based on Neuropsychological –Processing models: Conceptualization of intellectual functioning based on neuropsychological understanding of how various parts of the brain may function is valuable, especially if the brain is considered responsible for intelligence. This approach offers the hope for increased validity of intelligence tests because it provides model of functioning that rests on components of the functioning brain (Das, Naglieri & Kirby, 1994).

Some of the neuropsychological test batteries are: The Kaufman Assessment Battery for children (K-ABC) (Kaufman & Kaufman, 1983) and the Das-Naglieri Cognitive Assessment System (CAS; Naglieri & Das, 1997). However, factor analytic studies have confirmed that neuropsychological assessment of intelligence is more or less similar to the psychometric ability testing. For example, K-ABC sequential (successive) processing side corresponds to short-term memory ability and language processing and the simultaneous scale corresponds to broad visual processing (Carroll, 1993). In sum, as with psychometric ability batteries, construct validation is needed.

(3) Dynamic Assessment

It refers to diverse approaches that share some basis assumptions. It attempts to provide several types of information:

    a. more valid measures of abilities

    b. measures of different abilities

    c. insight into the cognitive processes the examinee uses or fails to use, and

    d. clues about the instructional methods that are most effective for the examinee (Campione & Brown, 1987, Haywood, Brown & Wingenfeld, 1990).

Intelligence Testing in India

Long and Mehta prepared a mental measurement handbook in 1966 listing out 103 tests of intelligence developed in various Indian languages (Dash, Mohanty, et al, 2004). S. M. Mohsin is considered to be one of the pioneers of intelligence testing in India. A few intelligence tests which have been developed are Jalota's intelligence test for adolescents (13-18 years) in 1971; Sharma's Draw-a-Bicycle test (11-16 years) in 1977; Phatak's Draw-a-Man (Woman) test revised in 1984; Sinha's Draw Yourself test in 1977; and Dubey's Reasoning ability Test in Hindi in 1977. The factorial and psychometric invariance of Raven's progressive Matrices (1947) and Wechsler Adult Intelligence Scale (1955) have been studied by Puhan over a series of well designed studies (1978c, 1979, 1982).

Though efforts have been made to develop tests of intelligence in India but most of the work relate to the standardization of the tests available in the foreign market on the Indian population. As very little effort has been made to develop mental ability test for children in India and standardize it on the Indian population it was thought imperative to work in that direction.

Methodology

For the purpose of this research, mental ability has been defined as the basic reasoning ability of an individual which he or she applies in problem solving of many kinds. The aim of the study was to develop a test of mental ability for school children (12-17 years of age) of Indian origin which include both verbal and non-verbal stimuli. The sample consisted of 600 school boys of which 200 boys were used for the actual try-out of the verbal and nonverbal mental ability tests, 200 were used for establishing the reliability index, 100 were used for establishing the validity index and another 100 boys were used for the establishment of norms which was done for the age group of 15-17 years.

The study was conducted in two phases. Phase I consisted of development of a test of mental ability. Components to be included for the measurement of mental ability was determined in this phase. An initial item bank was prepared and pre-testing and item analysis was done in this phase. The Phase II consisted of fixing the optimum limit of

the tests and establishing the reliability and validity indices of both the verbal and non-verbal tests. Norms for the age group 15-17 years was also prepared in this phase.

Construction of Items

The following five steps were used for development of this test, namely,

1. Planning the test,

2. Preparing the preliminary draft of the test,

3. Trying out the preliminary draft of the test,

4. Evaluating the test, and,

5. Construction of the final draft of the test.

The 'factor strcture of human abilities' as elucidated by Carroll (1993) was used for determining the components that were included in the measurement of mental ability. The following types of items were developed for the measurement of mental ability, namely, analogies (both verbal and non-verbal), classification or odd-man-out (both verbal and non-verbal), series or sequences (both verbal and non-verbal), numerical ability (only verbal), spatial ability (only non-verbal), perceptual speed and accuracy (only non-verbal), matrices (only non-verbal), deductive reasoning (only verbal), coding (only verbal) and verbal comprehension (only verbal).

Selection of Items

An initial item bank of 250 items both verbal and non-verbal were prepared which were scrutinized by a panel of judges on certain

parameters. Based on their suggestions 200 items were retained for the try-out of which 100 were verbal items and the other 100 were non-verbal items. Pre-tryout of the item bank was done on a representative population to check the tests for shortcomings which could be further improved.

Item analysis

The actual tryout was conducted on 200 school boys. Item analysis was done and all those items which fell within the difficulty range of .30 to .70 and discrimination index of .20 and beyond were retained. Based on the item analysis 40 items were retained for the verbal ability test and another 40 were retained for the non-verbal test. These items were then arranged in graded difficulty level and the most easy item was the first item of the test while the most difficult item was the last one in the test. The final verbal and non-verbal tests were administered on 200 school children to fix the optimum time limit for both the tests. Based on statistical parameters 20 minutes was fixed as the optimum time limit for both the verbal and non-verbal tests.

Reliability and Validity

Kuder-Richardson formula 20 was used for establishing the reliability of the tests. The reliability index for verbal mental ability test was .84 and .85 for the non-verbal mental ability test. Responses of 100 school boys on Raven's Standard Progressive Matrices (SPM) were used as the

validity criterion. The academic performance of this sample in the previous annual school examination was also taken as a criterion. The validity indices of the verbal mental ability test was .61 and .73 for the non-verbal test with SPM as the criterion while it was .47 and .35 for the verbal and non-verbal tests respectively with academic performance as the criterion. The validity indices were, therefore, highly significant with SPM as the validity criterion. For the development of norms both the verbal and non-verbal mental ability tests were administered on 100 school children of the age group of 15-17 years. The mean and standard deviations for both the verbal and non-verbal tests were computed. Norms were prepared by converting the raw scores of both the tests to standard scores (equivalent or converted scores). A mean of 50 and standard deviation of 10 were used for converting the raw scores for both the tests. The summed equivalent scores were divided into five point norms, namely, well above average intelligence, above average intelligence, average intelligence, below average intelligence and well below average intelligence.

Two mental ability tests, namely, a verbal and non-verbal test were developed in this study. The tests were standardized on psychometric principles on school children (boys) of 12-17 years of age. The reliability and validity indices of both the tests were found to be highly significant. Norms were prepared for the age group of 15-17 years.

CHAPTER 10

LIMITATIONS AND SUGGESTIONS

No research is ever perfect. Almost always there is a feeling that more could have been done. Any lacuna is suggestive of scope of improvement. Limitations are in fact a part and parcel of research work. Nevertheless, it is a research endeavour, one after another, always thriving for betterment and aiming to find more facts to understand any phenomenon close to reality, as far as practicable.

The present study is also no exception. Some of the limitations encountered by the investigator and suggestions for further research are outlined below:

(i)   The generalizations and trends occurring from this research are limited to the particular group of school children who formed a part of this research group. The sample size of 600 school boys represent a very small population of school boys in the country. Time constraint restricted the inclusion of a larger population. It is, therefore, suggested that a larger representation of both school boys and girls will lead to determining the mental ability indices of both these sexes.

(ii)   The cultural context for determining the components of mental ability have not been used as there are no such indices available. Though the components of mental ability as used in this research are

126

considered to be universal it is suggested that efforts should be made to determine the components in our cultural context.

(iii)   The present research concentrated on school boys from in and around the national capital region of Delhi. It is suggested that for determining the true mental ability index of school children (12-17 years) a more representative population from all over the country can be collected.

(iv)   The sample consisted of only school boys. No representation was taken from school girls for this project. As sex differences in intelligence, reasoning, hemispheric dominance, problem solving, personality and many other dimensions is a core subject for research all over the globe it is suggested that further research should be carried out with equal representation of both the male and female population.

(v)   The norms developed for this research work pertain to only school boys of 15-17 years. Age norms for the school boys from 12-15 years could not be developed because of paucity of time. It is suggested that for implementation of the mental ability tests the norms for the other age groups should also be developed.

REFERENCE

ANASTASI, A. (1950). The concept of validity in the interpretation of test scores. *Educational and Psychological Measurement*, 10, 67-68.

ANASTASI, A. (1982). *Psychological testing (4th ed.)*. New York: Macmillan.

ANASTASI, A. (1988). *Psychological testing (6th ed.)*. New York: Macmillan.

ANASTASI, A., & URBINA, S. (1997). *Psychological testing (7th ed.)*. Upper Saddle River, NJ: Prentice Hall.

AZUMA, H., & KASHIWAGI, K. (1987). Description for an intelligent person: A Japanese study. *Japanese Psychological Research*, 29, 17-26.

BARDOS, A.N. (2003). The General Ability Measure for Adults. In McCallum, R.S. (Ed.). Handbook of Nonverbal Assessment (pp 163-174). New York: Kluwer Academic/Plerum Publishers.

BARKOW, J.H., COSMIDES L., & TOOBY J. (1992). *The adapted mind*. New York: Oxford University Press.

BEVALI, U.K. (1981). *Concept of speed: A development cum training study*. Unpublished doctoral dissertation, University of Delhi, Delhi.

BEVALI, U.K. (1984). *An outline of research studies in the area of cognitive development*. Child Study Unit, NCERT, New Delhi.

BHAKOO, O.N., KAUR, S., NARANG, A., & VERMA, S.K. (1977). A longitudinal study of variations in Development quotients (DQs) in the first 30 months of life. *Indian Journal of Clinical Psychology*, 4, 59-68.

BINET, A., & HENRI, V. (1895). *La psychologie individuelle* (Psychology of the individual). L'Annee Psychologique, 2, 411-465.

BINET, A; & HENRI, V.(1896). *La psychologie individuelle.* L'Annee Psychologique; 2, 411-465.

BINET, A., & SIMON, T. (1916). *The development of intelligence in children.* Baltimore: Williams & Wilson. (Original work published 1905)

BORING, E.G. (1923). *Intelligence as the tests test it.* New Republic, 35, 35-37.

BROADBENT, D.E. (1958). *Perception and Communication.* New York: Pergamon Press.

BROOTA, K.D. (1988). Perceptual and Cognitive Processes. In Janak Pandey (Ed.),*Psychology in India The State-of-the-Art.*(Vol 1).New Delhi: Sage Publications.

BROWN,LINDA. (2003). Test of Nonverbal Intelligence: A language free measure of cognitive ability. In McCallum, R.S. (Ed.). Handbook of Nonverbal Assessment (pp191-221). New York: Kluwer Academic/Plerum Publishers.

BURT, C. (1955). The evidence for the concept of intelligence. *British Journal of Educational Psychology*, 25, 159-177.

BUSS, D.M. (1995). Evolutionary psychology: A new paradigm for psychological science. *Psychological Inquiry,* 6, 1-30

BUTTERWORTH, G. (1994). Infant intelligence. In J. Khalfa (Ed.), *What is intelligence?* (pp. 49-71). Cambridge University Press.

CAMPIONE, J.C, & BROWN, A.L. (1987). Linking dynamic assessment with school achievement. In C.S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 82-115). New York: Guilford Press.

CANTOR, N., & HARLOW, R. (1994). Social intelligence and personality : Flexible life task pursuit. In R.J. Sternberg, & P. Ruzgis (Eds.).,

Personality and intelligence. Cambridge: Cambridge University Press.

CARROLL, J.B. (1983). Individual differences in cognitive abilities. In Irvine, S.H. and Berry, J.W. (Eds.) (1983), *Human Assessment and Cultural Factors.* London. Plenum.

CARROLL, J.B. (1993). *Human cognitive abilities: A survey of factor-analytic studies.* New York: Cambridge University Press.

CATTELL, J.M. (1890). *Mental tests and measurements.* Mind, 15, 373-381.

CATTELL, R.B. (1971). *Abilities: Their structure, growth and action.* Boston; Houghton Mifflin.

CATTELL, R.B., & CATTELL, A.K.S. (1959). *Culture Fair Intelligence Tests: A measure of "g".* Illinois: Institute for Personality and Ability Testing.

CHADHA, N. K. (1996). *Theory and Practice of Psychometry.* New Delhi: New Age International Limited Publishers.

CHAKRABORTY, P.K. & KUNDU, R. (1979). A study of qualitative aspects of reasoning involved in number series items. *Bombay Psychologists*, 2 (1), 36-39.

CHATTOPADHYAY, P.K., & BHATTACHARYA, A.K. (1981b). Differentiation of the component of intelligence in successive age levels (4-7 yrs): a factor analytic study. *Child psychiatry quarterly*, 14 (2), 38-42.

CHEN, J., & GARDNER, H. (1997). Alternative assessment from a multiple intelligence theoretical perspective. In D.P. Flanagan, J.L. Genshaft & P.L. Harrison (Eds.). *Contemporary in intellectual assessment: Theories, tests, and issues. New York : Guilford Press..*

CHEN, M.J. (1994). Chinese and Australian concepts of intelligence. *Psychology and Developing Societies*, 6, 101-117.

,OHEN, R.J., MONTAGUE, P., NATHANSON, L.S., & SWERDLIK, M.E. (1988). *Psychological testing*. Mountain View, CA: Mayfield.

COLE, M., & COLE, S.R. (1993). *The development of children.* New York: Scientific American Books.

COLE, M., GAY, J., GLICK, J., & SHARP, D.W.(1971). *The cultural context of learning and thinking.* New York: Basic Books.

COX, M.V., BRYAND, D.C., & AGNIHOTRI, R.K. (1982). A cross cultural study of spatial ability in children. *Educational Psychology*, 2(1), 37-46.

CRONBACH, L.J. (1951). Coefficient alpha and the interval structure of tests. *Psychometrica*, 16, 297-334.

CRONBACH, L.J. (1975). Five decades of pubic controversy over mental testing. *American Psychologist,* 30, 1-14.

CRONBACH, L.J. & MEEHL, P.E. (1955). Construct validity in psychological tests. *Psychological Bulletin*, 52, 281-302.

DANIEL , M.H. (1997). Intelligence Testing : Status and Trends. *American Psychologist,* 52, 10, 1038, 1045.

Das, J.P. (2004). Theories of Intelligence: Issues and applications. In Goldstein,G & Beers, S.R. (Ed.), *Comprehensive Handbook of Psychological Assessment, Vol 1, Intellectual and Neuropsychological Assessment.* New Jersey: John Wiley & Sons, Inc.

DAS, J.P. (1994). Eastern views of intelligence. In Sternberg, R.J. (Ed.), *Encyclopedia of human intelligence* (Vol. 1, pp. 387-391). New York: Macmillan.

DAS, J.P. & DASH, U.N. (1983). Hierarchical factor solution of coding and planning processes: Any new insight? *Intelligence*, 7, 27-37.

DAS, J.P., KIRBY, J.R., & JARMAN, R.F. (1975). Simultaneous and successive synthesis : An alternative model for cognitive abilities. *Psychological Bulletin,* 82,87-103.

DAS, J.P., NAGLIERI, J.A., & KIRBY, J.R.(1994). *Assessment of cognitive processes: The PASS theory of intelligence.* Needham Heights, MA: Allyn & Bacon.

DASEN, P. (1984). The cross-cultural study of intelligence: Piaget and the Bole. *International Journal of Psychology,* 19, 407-434.

DASH, A.S., & RATH, S. (1984). An experimental study of the effects of cognitive stimulation. *Psychological Studies,* 29, 22-27.

DASH, U.N, & DAS, J.P. (1984). Development of concrete operational thought and information coding in schooled and unschooled children. *British Journal of Development Psychology,* 2, 63-72.

DASH, U., MOHANTY, S.C., NANDA, G.K., MOHANTY, P.K., PATTANAIK, L.K. & MISHRA, G.C. (2004). *Psychology, Part-1.* Bhubaneshwar, Orissa State Bureau of Textbook Preparation and production..

DESAI, K.G. (1980). Comparative factorial structure of Raven's Standard Progressive Matrices, Cattell's Culture Fair Scale: 3, and Desai-Bhatt's Group Test of Intelligence on samples of various subgroups of Gujarat. *Journal of Psychological Researches,* 24, 8-15.

DETTERMAN, D.K. & STERNBERG, R.J. (Eds.). (1986). *What is intelligence? Contemporary viewpoints on its nature and definition* (pp. 155-162). Norwood, NJ: Ablex.

DUBEY, L.N. (1977). *Reasoning Ability Test.* Agra: National Psychological Corporation.

DUBOIS, P. (1966). A test dominated society : China, 115BC-1905 AD. In A. Anastasi (Ed.)., *Testing Problems in Perspective* (pp. 29-36). Washington : American Council of Education.

)WECK, C.S. (1999). *Self-theories: Their role in motivation, personality, and development.* Philadelphia: Psychology Press.

EBBINGHAUS, H. (1897). In A. Anastasi (1982) *Psychological testing (4th ed.).* New York: Macmillan.

EDWARDS, A.L., & ABBOTT, R.D. (1973). Measurement of personality traits: Theory and technique. *Annual Review of Psychology*, 24, 241-278.

ELLIOT, C.D. (1990). *Differential Ability Scales.* San Antonio, TX : Psychological Corporation.

EMBRETSON, S.E. (1987). Toward development of a psychometric approach. In C.S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 141-170). New York: Guilford Press.

EMBRETSON, S.E. (1992). Measuring and validating cognitive modifiability as an ability: A study in the spatial domain. *Journal of Educational Measurement* , 29, 25-50.

EYSENCK, H.J. (1998)- *"A New Look Intelligence".* Transaction Publishers, New Brannswick, New Jersey.

EYSENCK, H.J., ARNOLD, W.J., & MEILI, R. (Eds.). (1975). *Encyclopedia of Psychology* (Vols 1 & 2). London: Fontana.

EYSENCK, H.J. & EYSENCK, M.W. (1985). *Personality and Individual Differences : A natural science approach.* New York : Plenum.GUTTFREDSON, L.S. (2002). Where and why g matters : Not a mystery, 15 (1/2), 25-46.

FEUERSTEIN, R., RAND, Y., & HOFFMAN, M. (1979). *The dynamic assessment of retarded performers: Learning potential assessment device, theory, instrument, and techniques.* Baltimore: University Park Press.

FISKE, D.W., & PEARSON, P.H. (1970). Theory and techniques of personality measurement. *Annual Review of Psychology*, 21, 41-86.ardized

testing. In B. Gifford & M. O'Connor (Eds.), *Alternative views of aptitude, achievement, and instruction.* Boston: Kluwer.

GALTON, F. (1869). *Hereditary genius: An inquiry into its laws and consequences.* London: Macmillan.

GALTON, F. (1883). *Inquiries into human faculty and its development.* London: Macmillan.

GARDNER, H. (1983). *Frames of mind: The theory of multiple intelligences.* New York: Basic.

GARDNER, H. (1992). Assessment in context: The alternative to standardized testing. In B. Gifford & M. O'Connor (Eds.), *Alternative views of aptitude, achievement and instruction.* Boston : Kluwer.

GARDNER, H. (1993). *Multiple intelligences: The theory in practice.* New York: Basic.

GARDNER, H. (1998). Are there additional intelligences? The case for naturalist, spiritual and existential intelligences. In J. Kane (Ed.), *Education, Information and Transformation* (pp. 111-132). Englewood Cliffs, NJ: Prentice Hall.

GARRETT, H.E. & WOODWORTH, R.S. (1981). *Statistics in Psychology and education.* Bombay Vakils, Feffer and Simons Ltd.

GILL, R, & KEATS, D.M. (1980). Elements of intellectual competence: Judgments by Australian and Malay university students. *Journal of Cross-Cultural Psychology,* 11, 233-243.

GUILFORD, J.P. (1954). *Psychometric Methods.* New York: McGraw Hill.

GUILFORD, J.P. (1967). *The nature of human intelligence.* New York: McGraw- Hill.

GUILLIKSEN, H. (1959). *Theory of Mental Tests.* New York : Wiley.

GUPTA, K. (1981).Perception of horizontality. *Indian Journal of Psychometry and Education*, 12(1), 45-48.

GUTHKE, J., & STEIN, H. (1996). Are learning tests the better version of intelligence tests? *European Journal of Psychological Assessment*, 12, 1-13.

HAKSTAIN, A.R. & CATTELL, R.B. (1994). The checking of primary ability structure on a broader basis of performance. British Journal of Educational Psychology, 44, 140-154.

HARKNESS, S., SUPER, C., & KEEFER, C. (1992). Culture and ethnicity. In M.D. Levine, & A.C. Crocker (Eds.), *Developmental-behavioral pediatrics.* (pp.103-108). Philadelphia: Sounders.

HAYWOOD, H.C., BROWN, A.L., & WINGENFELD, S. (1990). Dynamic approaches to psycho-educational assessment. *School Psychology Review,* 19, 411-422.

HEBB, D.O. (1949). *The organization of behavior.* New York: Wiley.

HORN, J.L. (1985). Remodeling old models in intelligence. In B.B. Wolman (Ed.), *Handbook of intelligence: Theories, measurements, and applications* (pp. 267-300). New York: Wiley.

HORN, J.L. (1989). Cognitive diversity: A framework of learning. In P.L. Ackerman, R.J. Sternberg, & R.Glaser (Eds.), *Learning and individual differences* (pp. 61-116). New York: Freeman.

HORN, J.L., & CATTELL, R.B. (1966). Refinement and test of the theory of fluid and crystallized intelligence. *Journal of Educational Psychology,* 57, 253-270.

HORN, J.L., & DONALDSON, G. (1976). On the myth of intellectual decline in adulthood. *American Psychologist,* 31, 701-719.

HORN, J.L., & HOFER, S.M. (1967). Age differences in fluid and crystallized intelligence. *Acta Psychologica,* 26, 107-129.

IORN, J.L., & HOFER, S.M. (1992). Major abilities and development in the adult period. In R.J. Sternberg & C.A. Berg (Ed.), *Intellectual development* (pp. 44-99). Boston, MA: Cambridge University Press.

HORN, K.L. (1994). Theory of fluid and crystallized intelligence. In R.J. Sternberg (Ed), *Encyclopedia of human intelligence* (pp.443-451). New York: Macmillan.

INTELLIGENCE AND ITS MEASREMENT: A symposium. (1921). *Journal of Educational Psychology,* 12, 123-147, 195-261, 271-275.

IYENGAR, D., & JAIN, U. (1979). Development of conservation in deaf and dumb children. *Journal of Psychological Researches*, 23(3), 135-140.

JALOTA, S., & TANDON, R.K. (1971). *Group Test of General Mental Ability.* Moradabad: Karuna Tandon.

JENSEN, A.R. (1969). How much can we boost IQ and scholastic achievement? *Harvard Educational Review*, 39, 1-123.

JERISON, H.J. (1982). The evolution of biological intelligence. In R.J. Sternberg (Ed,)., *Handbook of human intelligence* (pp. 723-791). New York : Cambridge University Press.

KAMPHAUS, R.W. (1993). *Clinical assessment of children's intelligence.* Boston, MA: Allyn & Bacon.

KAUFMAN, A.S, & KAUFMAN, N.L. (1983). *Kaufman Assessment Battery for Children.* Circle Pines, MN: American Guidance Service.

KAUFMAN, A.S. (1990a). *Assessing adolescent and adult intelligence.* Boston, MA: Allyn & Bacon.

KAUFMAN, A.S. (2000). Tests of Intelligence. In Sternberg, R. J. (Ed.), *Handbook of Intelligence.* U.K.: Cambridge University Press.

KAUFMAN, A.S., & KAUFMAN, N.L. (1983a). *Administration and scoring manual for Kaufman Assessment Battery for Children (K-ABC).* Circle Pines, MN: American Guidance Service.

KAUFMAN, A.S., & KAUFMAN, N.L. (1993). *Manual for Kaufman Adolescent & Adult Intelligence Test (KAIT).* Circle Pines, MN: American Guidance Service.

KEHOE, J.F. (2002). General Mental Ability and Selection in Private Sector Organisations : A commentary. *Human Performance,* 15 (1/2), 97-106.

KHIRE, U. (1999). *Technical Manual for a Computerized Battery for Intelligence and Aptitude Measurement.* Pune, JPIP.

KLINE, PAUL. (2000). *The Handbook of Psychological Testing.* (2nd Ed.). London: Routledge.

KUDER, G.F. & RICHARDSON, M.W. (1937). The theory of the estimation of test reliability. *Psychometrica,* 2, 151-160.

KULKARNI, S.S. & PUHAN, B.N. (1988). Psychological Assessment: Its Present and Future Trends. In Janak Pandey (Ed.), *Psychology in India- the State-of –the-Art,* (Vol 1, 19-91), New Delhi: Sage Publications.

KUNDU, R. & CHAKRABORTY, P.K. (1979). Development of a test of reasoning. *ISPT Journal of Research,* 2, 20-27.

LURIA, A.R. (1966). *Higher cortical functions in man.* New York : Basic Books.

LURIA, A.R. (1973). *The working brain: An introduction to neuropsychology.* New York : Basic Books.

LURIA, A.R. (1980). *Higher cortical functions in man (2nd ed; rev. & expanded).* New York: Basic Books.

MAYER, J.D., & SALOVEY, P. (1997). What is emotional intelligence ? In. P. Salovey, & D. Sluyter (Eds)., *Emotional development and emotional intelligence.* New York : Basic Books.

McCALLUM,R.S. (2003). The Universal Nonverbal Intelligence Test. In McCallum, R.S. (Ed.). Handbook of Nonverbal Assessment (pp87-111). New York: Kluwer Academic/Plerum Publishers.

MEEKER, M.N., MESTYANEK, L., SHADDUCK, R., & MEEKER, R. (1975). *S.O.I. Learning Abilities Test.* El Segundo, CA : SOI Institute.

MESSICK, S. (1975). The standard problem: Meaning and values in measurement and evaluation. *American Psychologist,* 30, 955-966.

MESSICK, S. (1980). *The effectiveness of coaching for the SAT : Review and reanalysis of research from the fifties to the FTC.* Princeton, N.J. : Educational Testing Service.

MISRA, G., & GERGEN, K.G. (1993). On the place of culture in psychological science. *International Journal of Psychology*, 28, 225-243.

MUKHERJEE, B.N. (1980). Psychological theory and research methods. In U.Pareek (Ed), *A survey of research in psychology*, 1971-76 (Part 1, pp. 3-135). Bombay: Popular Prakashan.

MUNDY-CASTLE, A.C. (1974). Social and technological intelligence in western and non-western cultures. *Universitas*, 4, 46-52.

MURALIDHARAN, R., & KAUR, B. (1984). *The impact of an intervention program on the language and cognitive development of tribal preschool children.* (Available from Child Study Unit, NCERT, New Delhi 110016.)

NAGLIERI,J.A. (2003). Naglieri Ability Tests: NMAT and MAT-EF. In McCallum, R.S. (Ed.). Handbook of Nonverbal Assessment (pp175-189). New York: Kluwer Academic/Plerum Publishers.

NAGLIERI, J.A., & DAS, J.P. (1997a). *Das-Naglieri Cognitive Assessment System.* Chicago : Riverside.

138

NAGLIERI, J.A. & DAS, J.P. (1997b). *Cognitive Assessment System Interpretive Handbook.* Chicago : Riverside.

NAGLIERI, J.A. (1997). *Naglieri Nonverbal ability Test (NNAT) Multilevel Technical Manual.* San Antonio, TX: Harcourt Brace Educational Measurement.

NARAYANA RAO, S. (1977). *Concept development in children* (Monograph 1). Unpublished manuscript, S.V. University, Tirupati.

NARAYANA RAO, S., & REDDY, I.K.S. (1977). *Concept development in children* (Monograph 2). Unpublished manuscript, S.V. University, Tirupati.

NEISSER, U. (1967). *Cognitive Psychology.* New York: Appleton-Century-Crofts.

NEISSER, U. (1979). The concept of Intelligence. In STERNBERG, R.J., & DETTERMAN D.K. (Ed.). (1986). *What is intelligence? Contemporary viewpoints on its nature and definition.* Norwood, NJ:Ablex.

NEISSER, U., BOODOO, G., BOUCHARD, T.J., Jr., BOYKIN, A.W., BRODY, N., CECI, S.J., HALPERN, D.F., LOEHLIN, J.C., PERLOFF, R., STERNHERG, R.J., URBINA, S. (1996). Intelligence: Knowns and unknowns. *American Psychologist,* 51,77-101.

NUNNALLY, J.C., Jr. (1970*). Introduction to psychological measurement.* New York: McGraw-Hill.

OTIS, A.S. & LENNON, R.T. (1997). *Otis-Lennon School Ability Test (OSLAT), 7th Ed., Technical Manual, Spring data.* San Antonio, TX: Harcourt Brace Educational Measurement.

PAWLIK, K. (1998). The Psychology of individual differences: the personality puzzle. In Pawlik, K., *Dimensionen des Verhaltens (Dimensiens of behaviour).* Bern, Suitzerland : Huber.

PEARSON,N. (2003). Comprehensive Test of Nonverbal Intelligence. In McCallum, R.S. (Ed.). Handbook of Nonverbal Assessment (pp141-161). New York: Kluwer Academic/Plerum Publishers.

PERSHAD, D., VERMA, S.K., & RANDHAWA, A. (1979). Preliminary report on a performance test of intelligence on 4-8 year old children. *Indian Journal of Clinical Psychology*, 6, 125-130.

PHATAK, P. (1984). Revision and extension of Phatak Draw-A-Man Scale for Indian children of age groups 2.5 to 16.5 years. *Psychological Studies*, 29, 34-46.

PIAGET, J. (1952). *The origins of intelligence in children.* New York: International University Press.

PUHAN, B.N. (1978c). Factorial validity of Advanced Progressive Matrices and Culture Fair Intelligence Test: scale *3. Bombay Psychologist, 1(1), 22-27*

PUHAN, B.N. (1979a). Assessment of psychometric invariance across sex groups. *Indian Educational Review*, 15, 54-69.

PUHAN, B.N. (1979b). Comparison of WAIS factor structures across 18-19 and 25-34 age groups. *Indian Journal of Psychology,* 53, 20-28.

PUHAN, B.N. (1979c). *The assessment of psychometric invariance of Weschsler Adult Intelligence subscales across two age groups.* New Delhi: Allied.

PUHAN, B.N. (1982). *Issues in psychological measurement.* Agra: National Psychological Corporation.

RAM, U. (1978). *Measurement of the degree of mental retardation.* Unpublished doctoral dissertation, Poona University, Pune.

RATH, R., & PATNAIK, N. (1979) . Effect of training on some cognitive abilities. *Journal of Psychological Researches*, 23, 81-92.

RAVEN, J.C. (1947). *Progressive Matrices.* London: L.K. Lewis.

RAVEN, J.C. (1960). *Guide to the Standard Progressive Matrices.* London: H.K. Lewis & Co. Ltd.

RAVEN, J.C. (1965a). *Progressive Matrices.* London, H.K. Lewis.

REE, M.J., & CARRETTA, T.R. (2002). g2k. *Human Performance,* 15 (1/2), 3-23.

ROID, G., NELLIS, L., & McLELLAN,M. (2003). Assessment with the Leiter International Performance Scale- Revised and the S-BIT. In McCallum, R.S. (Ed.). Handbook of Nonverbal Assessment (pp113-140). New York: Kluwer Academic/Plerum Publishers.

SALGADO, J.F., & ANDERSON, N. (2002). Cognitive and GMA Testing in the European Community: Issues and Evidence, *Human Performance*, 15 (1/2), 75-96.

SALVIA, J., & YSSELDYKE, J.E, (1981). *Assessment in special and remedial education* (2nd ed.). Boston: Houghton Mifflin.

SARASWATHI, T.S. & RANJANA DUTTA. (1988). Current Trends in Developmental Psychology. In Janak Pandey (Ed.), *Psychology in India- the State-of –the-Art,* (Vol 1, 93-151), New Delhi: Sage Publications.

SCHEIBEL, A. (1996). *Introduction to symposium on the evolution of intelligence.* Los Angeles: Center for the Study of Evolution and Origin of Life, University of California.

SERPELL, R, (1982). Measures of perception, skills, and intelligence. In W.W. Hartup (Ed*), Review of child development research* (vol. 6, pp.392-440). Chicago: University of Chicago Press.

SHARMA, T.R. (1977*). Sharma Draw-a-Bicycle Test of Intelligence.* Agra: National Psychological Corporation.

IEGLER, R.S, & RICHARDS, D.D. (1982). The development of intelligence. In R.J. Sternberg (Ed), *Handbook of human intelligence* (pp.896-971). New York: Cambridge University Press.

SIMON, H.A. (1976). Identifying basic abilities underlying intelligent performance of complex tasks. In L.B. Resnick (Ed.), *The nature of intelligence*. Hillsdale, N.J.: Erlbaum.

SINHA, M. (1977). Validity of the Progressive Matrices Tests. *Journal of Psychological Researches*, 21, 221-226.

SPEARMAN, C. (1904a). "General Intelligence" objectively determined and measured. *American Journal of Psychology*, 15, 201-293.

SPEARMEN, C. (1927). *The abilities of man*. London: Macmillan.

SRIVASTAVA, A.K., & MISRA, G. (1996). Changing perspectives on understanding intelligence: An appraisal. *Indian Psychological Abstracts and Review*, 3,1-34.

SRIVASTAVA, A.K., & MISRA, G. (2001). Lay People's understanding and use of intelligence: An Indian Perspective. *Psychology and Developing Societies,* 13, 1. New Delhi, Sage Publications.

STERN, W. (1900). Uber Psychology der individuellen Differenzen (On the Psychology of individual differences). Leipzig: Barth.

STERNBERG, R. J, & BERG, C.A. (1986). Quantitative integration: Definitions of intelligence: a comparison of the 1921 and 1986 symposia. In R.J. Sternberg & D.K. (Ed.). (1986). *What is intelligence? Contemporary viewpoints on its nature and definition.* Norwood, NJ:Ablex.

STERNBERG, R.J., & SALTER W. (1982). Principles of Psychology Today. In Bower, G.H. et al (Ed.)., *Principles of Psychology*. Norwood, NJ:Ablex.

STERNBERG, R.J. (1977). *Intelligence, information processing and analogical reasoning: The componential analysis of human abilities.* Hillsdale, NJ: Erlbaum.

TERNBERG, R.J. (1981). Novelty-seeking, novelty-finding, and developmental continuity of intelligence. *Intelligence*, 5, 149-155.

STERNBERG, R.J. (1985a). *Beyond IQ: A triarchic theory of human intelligence.* New York: Cambridge University Press.

STERNBERG, R. J. (1985c). Implicit theories on intelligence, creativity, and wisdom. *Journal of Personality and Social Psychology*, 49, 607-627

STERNBERG, R.J. (1988). *The triarchic mind: A new theory of human intelligence.* New York: Viking Press.

STERNBERG, R.J. (1990). *Wisdom: Its nature, origins and development.* Cambridge: Cambridge University Press.

STERNBERG, R.J. (1997). *Successful intelligence.* New York: Plume.

STERNBERG, R.J., & DETTERMAN D.K. (EDS.). (1986). *What is intelligence? Contemporary viewpoints on its nature and definition.* Norwood, NJ:Ablex.

STERNBERG, R.J., & LUBART, T.I. (1996). Investing in creativity. *American Psychologist,* 51, 677-688.

STERNBERG, R.J., (1996b). *Successful intelligence.* New York: Simon & Schuster.

SWANSON, H.L. (1996). *Swanson Cognitive Processing Test.* Austin, IX:PRO-ED.

TAKAHASHI, M., & BORDIA, P. (2000). The concept of wisdom: a cross-cultural comparison. *International Journal of Psychology,* 35, 1-9.

TCS/2 Technical Report. (1993). *Test of Cognitive Skills.* Monterey, CA: CTB Macmillan, McGraw-Hill.

ENOPYR, M.L. (2002). Theory Versus Reality: Evaluation of g in the workplace, 15 (1/2), 107-122.

TERMAN, L.M. & MERRILL, M.A. (1973). *Stanford-Binet Intelligence Scale: 1972 Norms edition.* Boston, MA: Houghton Mifflin.

TERMAN, L.M. (1916). *The measurement of intelligence.* Boston, MA: Houghton Mifflin.

TERMAN, LEWIS. (1925). Genetic studies of genius: Vol 1. *Mental and Physical traits of a thousand gifted children.* Stanford, CA : Stanford University Press.

TERMAN, L.M. & MERRILL, M.A. (1960). *Stanford-Binet Intelligence Scale: Manual for the third revision, Form L-M.* Boston: Houghton Mifflin.

THORNDIKE, R.L., & HAGEN, E.P. (1993). *Cognitive Abilities Test (CogAT), Form 5, Technical Manual.* Chicago: Riverside.

THORNDIKE, R.L., HAGEN, E.P., & SATTLER, J.M. (1986). *Stanford-Binet Intelligence Scale (4th ed.).* Itasca, IL: Riverside.

THORNDIKE, R.L., HAGEN, E.P., & SATTLER, J.M. (1986). *Technical Manual for the Stanford-Binet Intelligence Scale (4th ed.).* Chicago: Riverside.

THURSTONE, L.L. (1938). *Primary mental abilities.* Chicago: University of Chicago Press.

TRIPATHI, L.B. (1988). Higher Mental Processes. In Janak Pandey (Ed.), *Psychology in India- the State-of –the-Art,* (Vol 1, 289-328), New Delhi: Sage Publications.

VERMA, S.K., PERSHAD, D., & RANDHAWA, A. (1980). Are Indian children slow? Report of an enquiry with a speed measure of intelligence. *Child Psychiatry Quarterly,* 13(3), 67-71.

YGOTSKY, L.S. (1978). *Mind in society : The development of higher psychological processes.* Cambridge, M.A. : Harvard University Press.

VECHSLER, D. (1939). *The measurement of adult intelligence.* Baltimore: Williams & Wilkins.

WECHSLER, D. (1944). *The measurement of adult intelligence (3rd ed.).* Baltimore: Williams & Wilkins.

WECHSLER, D. (1955). *Manual for Wechsler Adult Intelligence Scale.* New York: Psychological Corporation.

WECHSLER, D. (1958). *The measurement and appraisal of adult intelligence* (5th ed.). Baltimore: Williams & Wilkins.

WECHSLER, D. (1975). Intelligence defined and undefined: a relativistic appraisal. *American Psychologist,* 30, 135-139.

WECHSLER, D. (1981). Manual for the Wechsler adult Intelligence Scale-Revised (WAIS-R). San Antonio, TX: The Psychological Corporation.

WECHSLER, D. (1989). Manual for the Wechsler Preschool and Primary Scale of Intelligence- revised (WPPSI-R). San Antonio, TX: The Psychological Corporation.

WECHSLER, D. (1991). *Manual for the Wechsler Intelligence Scale for Children- Third edition (WISC-III).* San Antonio, TX: Psychological Corporation.

WECHSLER, D. (1991). *Wechsler Intelligence Scale for Children-Third edition (WISC-III).* San Antonio, TX: Psychological Corporation.

WECHSLER, D. (1997a). Wechsler Adult Intelligence Scale-Third Edition. San Antonio, TX : The Psychological Corporation.

WECHSLER, D. (1997b). Wechsler Memory Scale- Third Edition. San Antonio, TX: The Psychological Corporation.

/HITE, R.W. (1959). Motivation reconsidered: The concept of competence. *Psychological Review*, 66, 297-333.

/INK, P., & HELSON, R. (1997). Practical and transcendental wisdom : Their nature and some Longitudinal findings. *Journal of Adult Development,* 4, 1-15.

WOBER, M.   (1974). Towards an understanding of the Ugandan concept of intelligence.   In J.W, Berry & P.R. Dasen (Eds.) *Culture and cognition: Readings in crosscultural psychology* (pp. 261-280). London: Methuen.

WOODCOCK, R.W., & JOHNSON, M.B. (1977). *Woodcock-Johnson Psycho-Educational Battery.* Allen, TX: DLM/ Teaching Resources.

WOODCOCK, R.W., & JOHNSON, M.B. (1989). *Woodcock-Johnson Tests of Cognitive Ability-Revised.* Itasca, IL: Riverside.

WRIGHT, R. (1994). *The moral animal.* New York :Vintage.

YANG, S. & STERNBERG, R.J. (1997a).   Conceptions of intelligence   in ancient Chinese philosophy. *Journal of Theoretical and Philosophical Psychology,* 17, 101-119.

YANG, S., & STERNBERG, R.J. (1997b).   Taiwanese Chinese people's conceptions of intelligence. *Intelligence,* 25, 21-36.

YOAKUM, C.S., & YERKES, R.M. (1920). *Army Mental Tests.* New York: Henry Holt.

YUSSEN, S.R. & KANE, P. (1985). Children's concept of intelligence. In S.R. Yussen (Ed.), *The growth of reflective thinking in children* (pp.207-241). New York: Academic Press.

APPENDICES

MENTAL ABILITY TEST

(VERBAL)

INSTRUCTIONS:

1.   This is a test of your ability to solve problems quickly and correctly. Try to do as many problems as possible. Do your best.

2.   All your answers must be recorded on the answer sheet provided to you along with the booklet. DO NOT MARK THIS BOOKLET IN ANY WAY. Write your answers in the appropriate column for answers against the relevant problem number.

3.   Give only ONE ANSWER to each problem. If you wish to alter or amend your answer on the answer sheet, cross the one you have already put and write the new answer legibly.

4.   If you find any problem too difficult, proceed to the next. Do not waste time on the difficult problems. You may return to the left out problems after finishing the test.

5.   No questions about the test will be answered after the testing begins.

6.   A few illustrations of the type of questions that you will find in the test are given on the next page.

INSTRUCTIONS & ILLUSTRATIONS

xample-1

nstruction: Find out the word which does not belong to the same class as the others.

Potato, Onion, Raddish, Ginger, Tomato

(a) Potato   (b) Onion   (c) Tomato   (d) Ginger

Solution: Out of the above mentioned vegetables, all except for tomato grows underground. Therefore, choice 'B' is the answer as tomato does not belong to the same class as the others. Choice 'c' is written against Example '1' on your answer sheet.

Example-2

■■■
Instruction: Two objects, events or concepts are related in same way. You have to establish the same relationship with the third and fourth object, event or concept on the basis of the alternatives given below each question.

Zoo : Animal :: Aquarium : ?

(a) Birds   (b) Fish   (c) Bees   (d) Butterflies

Solution: A zoo is a place where animals are kept and an aquarium is a place where live fish and other water creatures are kept. Therefore, choice 'b' is the correct answer and is written against Example '2' on your answer sheet.

Example-3

Instruction: If LUNCH is coded as 58 then DINNER would be coded as

(a) 46   (b) 66   (c) 62   (d) 64

Solution: Each alphabet starting from A is assigned a numerical value. For eg, A = 1; B = 2;
C = 3 and so on. Therefore, DINNER will be coded as follows – D = 4; I = 9; N = 14; N = 14;
E = 5 and R = 18 which when added gives the value of 64. Choice 'd' is the correct answer and is written against Example '3' on the answer sheet.

Example-4

Instruction: Arrange the following words as they appear in the dictionary.

(a) jewel   (b) jiggle   (c) jungle   (d) jelly

(a) acbd   (b) dabc   (c) dbac   (d) bdca

Solution: The sequence in which the words would appear in the dictionary would be jelly, jewel, jiggle and jungle. Therefore, choice 'b' is the correct answer and is written against Example '4' on the answer sheet.

Example-5

Instruction: Write the choice of the alphabets which will come next in the series.

rscdstdetuef……..

(a) uv   (b) vw   (c) uw   (d) fg   (e) wv

Solution: There are two sequences being followed in the series. The first is 'rs' and the next sequence is 'cd'. If you split the series written above, it wuld look like this.

rs cd st de tu ef ….

To continue with the series the alphabet pair which should follow would be 'uv' which is written in choice 'a'. Therefore choice 'a' is the correct answer and is written against Example '5' on the answer sheet.

Example-6

Instruction: If the interchanges are made in signs and numbers, which one of the four equations would be correct?

Interchange: Sign + and ÷ and number 3 and 6.

(a) $3 + 6 \div 2 = 4$ (b) $6 + 3 \div 4 = 2.5$

(c) $6 \div 3 + 3 = 6$ (d) $3 + 6 \div 6 = 10$

Solution: By interchanging the signs + and ÷ and numbers 3 and 6, we get,

(a) $6 \div 3 + 2 = 4$ or $4 = 4$, which is true

(b) $3 \div 6 + 4 = 3.5$ or $3.5 = 2.5$, which is false

(c) $3 + 6 \div 3 = 5$ or $5 = 6$, which is false

(d) $6 \div 3 + 6 = 8$ or $8 = 10$, which is false

Therefore, choice 'a' is the correct answer and is written against Example '6' on the answer sheet.

Example-7

Instruction: A is taller than B but not as tall as C. C is taller than D. D is taller than A but not as tall as C.

Who is the tallest of them all?

(a) a   (b) b   (c) d   (d) c

Solution: The analysis of the above proposition reveals that C is the tallest. Therefore, choice 'd' is the correct answer and is written against Example '7' on the answer sheet.

You will get similar problems in the test. In all, there are 100 problems

to be solved in this test

DO NOT TURN OVER THE PAGE UNLESS ASKED TO DO SO

MENTAL ABILITY TEST - VERBAL

Instructions: Find out the word or number, which does not belong to the same class as the others.

(1) Mango, guava, grapes, potato, pineapple

    (a) Guava   (b) Pineapple   (c) Potato   (d) Grapes

(2) Cock and Hen, Horse and Mare, Peacock and Peahen, Dog and Bitch, Cow and Goat

    (a) Cow and Goat   (b) Horse and Mare

    (c) Peacock and Peahen   (d) Cock and Hen

(3) Lion and Den, Cow and Kennel, Pig and Pen, Hen and Farm, Horse and Stable

    (a) Lion and Den   (b) Cow and Kennel

    (c) Pig and Pen   (d) Hen and Farm

(4) JIHGJ, ONMLK, UTSRQ, XWVUT, CDEFGG

    (a) CDEFG   (b) ONMLK   (c) JIHGF   (d) UTSRQ

(5) Teacher, Principal, Student, Lecturer, Professor

    (a) Student   (b) Professor   (c) Principal   (d) Reader

(6) Crow, Pigeon, Sparrow, Bird, Kite

    (a) Pigeon   (b) Kite   (c) Crow   (d) Bird

(7) Whale, Crocodile, Tiger, Fish, Tortoise

    (a) Tiger   (b) Whale   (c) Tortoise   (d) Fish

(8) Sparrow, Eagle, Crow, Ostrich, Kite

    (a) Ostrich   (b)Eagle   (c) Kite   (d) Sparrow

(9) Bowl, Plate, Bucket, Cup, Pan

   (a) Bowl   (b) Bucket   (c) Cup   (d) Pan

(10) In the group of the following numbers one does not belong to the group. Which is
   that number?

   (a) 7   (b) 16   (c) 13   (d) 19   (e) 5

(11) In the group of the following numbers one does not belong to the group. Which is
   that number?

   (a) 4   (b) 6   (c) 5   (d) 2   (e) 8

(12) Three of the following are like in a certain way and so they from a group. Which is
   the one that does not belong to the group?

   (a) ABA   (b) DED   (c) KLL   (d) GHG

(13) Find out the number which does not belong to the same class as the others.
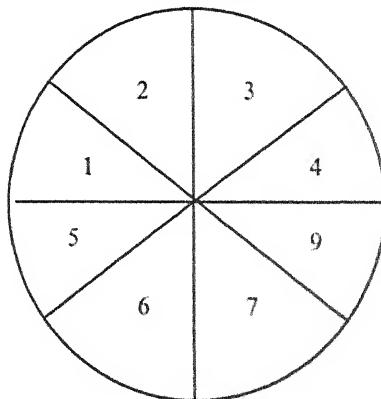
   (a) 2   (b) 4   (c) 5   (d) 9   (e) 1

Find out the number which does not belong to the same class as the others.
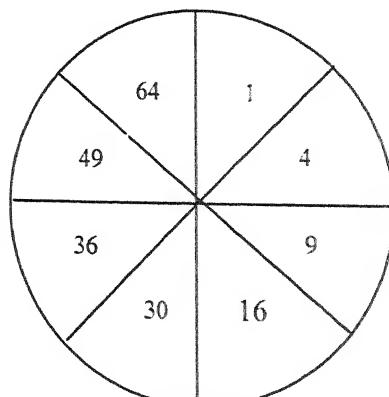
(a) 30   (b) 49   (c) 4   (d) 9   (e) 16

(15) Find out the number which does not belong to the same class as the others.
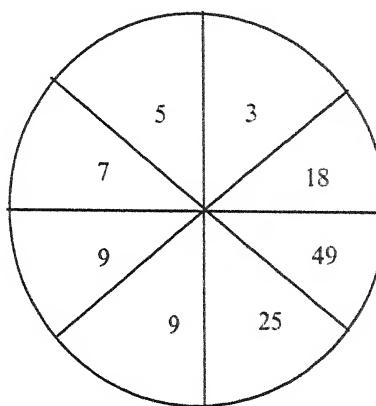
(a) 36   (b) 18   (c) 16   (d) 9   (e) 49

Instructions: Two objects, events or concepts are related in some way. You have to establish the same relationship with the third and the fourth object, event, or concept on the basis of the alternatives given below each question.

(16) Disease : Pathology :: Planet : ?

     (a) Sun   (b) Stars   (c) Astrology   (d) Astronomy

(17) Doctor : Medicine :: Teacher : ?

     (a) Class   (b) Students   (c) Knowledge   (d) Grades

(18) Metre : ? :: Litre : Volume

    (a) Weight   (b) Length   (c) Square   (d) Area

(19) Ohm : Resistance :: Watt : ?

    (a) Electricity   (b) Power   (c) Current   (d) Potential.

(20) Atom : Molecule :: Element : ?

    (a) Electron   (b) Mixture (c) Isomer   (d) Isotope

(21) Executive functions: President : : Legislative functions : ?

    (a) Defence Minister   (b) Prime Minister

    (c) Speaker   (d) Home Minister

(22) ABC : ZYX :: CBA : ?

    (a) ZXY   (b) BCA   (c) XYZ   (d) XZY

(23) ADE : FGJ :: KNO : ?

    (a) PQT   (b) PQR   (c) STQ   (d) PRS

(24) UTS : FDC :: WVU : ?

    (a) YWV   (b) GFE   (c) UVW   (d) HGE

(25) NUMBER : UNBMRE :: GHOST : ?

    (a) HGSOT   (b) TSOGH   (c) OGHST   (d) SOTGH

(26) EGIK : FILO :: FHJL : ?

    (a) GJMP   (b) GJPM   (c) HGMN   (d) GMJO

Two objects or events are related in some way. You have to pick out only that option which has the same type of relationship as stated in each question from the alternatives
given below each question.

(27) Carpenter and Wood

    (a) Goldsmith and Gold   (b) Engineer and Machines

    (c) Blacksmith and Iron   (d) All of the above

(28) Tree and Forest

    (a) Ocean and Ships   (b) Books and Letters

    (c) Books and Library   (d) Boys and Teacher

(29) Man : Child :: Flower : ?

    (a) Bud   (b) Fruit   (c) Branch   (d) Plant

(30) Milk and Butter are related in the same way as...

    (a) Tea and Coffee   (b) Rice and Curd

    (c) Grapes and Wine   (d) Potato and Juice

(31) If "CERTAIN" is coded as "XVIGZRM" in a particular code language, then how
    can "MUNDANE" be coded in that language?

    (a) NFMWZMX   (b) VMZWMFN   (c) NFMWZMV   (d) MFMXZMV

Substitute letters of the alphabet for series of digits, each of which will spell out a word

A E U B D G C F H

1 2 3 4 5 6 7 8 9

(32)	FACE	(a) 18127	(b) 8182	(c) 8712	(d) 8172
(33)	536	(a) DCG	(b) DED	(c) DUG	(d) DUC
(34)	915	(a) HAG	(b) HAD	(c) HAB	(d) HAE
(35)	HUGE	(a) 9362	(b) 9632	(c) 9236	(d) 9262
(36)	4215	(a) BEAD	(b) DEAD	(c) HEAD	(d) BEED
(37)	7162	(a) GAGE	(b) CAGE	(c) CEGE	(d) CAGF

(38) If FATHER is coded as '612859' and 'MOTHER' is coded as '462859', cc
for 'UNCLE' and 'AUNT' would be _____ & _____

    (a)   35353 & 1253
    (b)   33535 & 3125
    (c)   53535 & 5123
    (d)   35335 & 1352

(39) If 'SILVER' is coded as '5' and 'GOLD' is coded as '7' then 'DIAMOND'
would be coded as_____.

    (a)   3
    (b)   2
    (c)   35
    (d)   15

(40) If 'KING' is coded as 'PRMT' and 'QUEEN' is coded as 'JFVVM', then
'PRINCE' will be coded as _____.

    (a)   KIRVMX
    (b)   KIRMVX
    (c)   KIRMXV
    (d)   KIMRVX

(41) If 'HUV' is 'RED' and 'GYU' is 'SAD' then 'HUYV' would be
_____?

    (a) DERAR
    (b) ARED
    (c) READ
    (d) ERDA

(42) 'AAJTAK' and 'SAHARA' news channels got the ranks of '46' and '42'
respectively, what will be the rank for 'NDTV' news channel?

    (a)   21
    (b)   24
    (c)   40
    (d)   50

157

(43) 'FIRE' and 'WATER' are coded as 'SPGT' and 'BXETG', what is the code for 'EARTH'?

    (a)   TXGQR
    (b)   GETXQ
    (c)   EXTGQ
    (d)   TXGEQ

(44) If 'CLAIM' is coded as 'DNDMR' then 'CHARGE' will be coded as?

(a) DJDVLK   (b) DJDWLL   (c) DJCVMK   (d) DIDWKL

(45) If 'COLD' is coded as 'FSQT' then 'HEAT' will be coded as?

(a) KJFY   (b) KIGZ   (c) KIFZ   (d) YIGY

(46) Which of the following is the largest expression?

(a) 3.8x4.3   (b) 230   (c) $39.36 \div 2.70$ (d) 6015/369

Instructions: Write the choice of the alphabet which will come next in the series?

(47) abcd abce abcf abcg…

(a) adch   (b) abch   (c) abck   (d) abdh   (e) acbh

(48) mnomoompom…

(a) qo   (b) qr   (c) pq   (d) qp   (e) ro

(49) abmcdmefmghm…

(a) jim   (b) him   (c) ijk   (d) jkm   (e) ijm

(50) qxapxboxc …

(a) nxc   (b) mcd   (c) nxd   (d) nxe   (e) mxd

(51) aduacuaeuabuaf….

(a) uaa   (b) uag   (c) afa   (d) ufa   (e) uac

(52) mabmbcmcdm….

(a) da   (b) de   (c) dd   (d) ef   (e) ed

(53) npaoqapraqsa…

(a) rua   (b) sta   (c) rsa   (d) rta   (e) qra

Instructions: Write the choice of the number which will replace the question mark in the matrix.

(54)

2	4	6
3	6	?
4	8	12

(a) 7   (b) 9   (c) 8   (d) 10   (e) 11

(55)

5	15	10
20	30	25
?	45	40

(a) 25   (b) 40   (c) 50   (d) 35   (e) 30

(56)

1	11	23
?	13	25
5	15	?
7	17	29

(a) 27, 4   (b) 2, 17   (c) 3, 27   (d) 10, 26   (e) 3, 17

(57)

1	6	21
2	10	?
3	15	36

(a) 28   (b) 26   (c) 24   (d) 32   (e) 34

(58)

4	9	16
25	?	49
64	?	100

(a) 27, 71   (b) 36, 81   (c) 32, 79   (d) 34, 73   (e) 35, 75

(59)
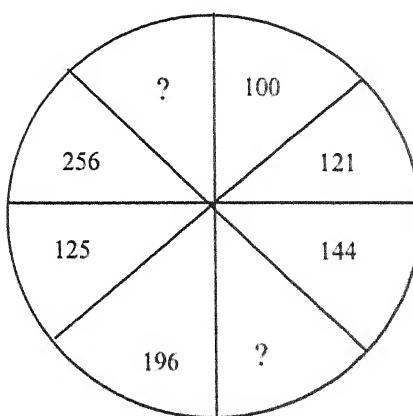
(a) 159, 269   (b) 162, 289 (c) 169, 289 (d) 152, 356 (e) 166, 336

(60)
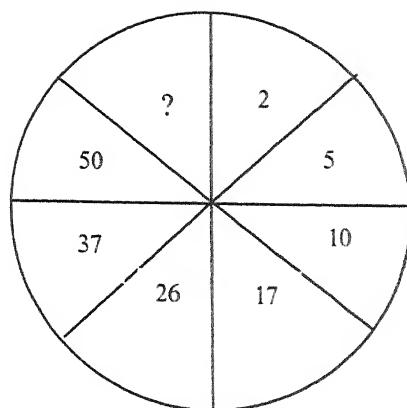
(a) 57   (b) 62   (c) 60   (d) 65   (e) 72

(61) Write the two letters, which are next to each other in the alphabet and also next to
each other in this word DISTANCE

(a) IS   (b) CE   (c) ST   (d) DI   (e) TA

(62) Write the letter which is in the same position from the end of the alphabet as
'D" is
from the beginning.

(a) W   (b) X   (c) Y   (d) Z   (e) U

(63) Write the letter of the alphabet, which comes midway between D and H.

(a) E   (b) F   (c) G   (d) H   (e) I

(64) Write down the letters, which are in the same position to one another in the
word 'ARCH' as they are in the alphabet.

(a) AC   (b) AR   (c) CH   (d) RC   (e) AH

(65) Many words can be produced from the given word. They are grouped into four clusters.
One of the clusters contains a word that cannot be produced from the given word.   Which is that cluster?
Given word: FRAGRANCE

(a) GRACE, FARE, RAN

(b) FAR, RAGE, RARE

(c) FRANCE, GLANCE, CAR

(d) ARE, CAN, RAG

Use the sequence of the alphabets (A to Z) for doing Q No.66 to Q No.73.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

(66) The second letter before the sixth letter is..

(a) C
(b) D
(c) E
(d) F
(e) B

(67) What letter comes midway between G and O..

(a) L
(b) K
(c) J
(d) I
(e) M

(68) What letter comes before the letter which comes before M..

(a) K
(b) L
(c) M
(d) J
(e) I

(69) What letter comes after the letter which comes after D..

(a) E
(b) G
(c) F
(d) C
(e) H

(70) What letter is the fifth letter after the letter, which comes midway between L and R...

(a) P
(b) R
(c) Q
(d) S
(e) T

(71) What letter comes just after the fifth letter after E..

(a) H
(b) L
(c) I
(d) K
(e) J

(72) Suppose the first and second letters of the alphabet were interchanged, also the third and fourth, the fifth and sixth, and so on. Which letter would then come 17th….

(a) Q   (b) T   (c) R   (d) S   (e) T

(73) Suppose the 3rd letter of the alphabet were crossed out, also the 6th, the 9th, the 12th,
and so on. What would be the fifth letter not crossed out….

(a) H   (b) G   (c) J   (d) D   (e) B

(74) Arrange the following words as they appear in the dictionary.

(i) Asthma   (ii) Aeroplane (iii) Aesthetic (iv) Astronaut

(a) acdb   (b) bcda   (c) bcad   (d) adbc   (e) bdca

(75) Which set of letters follow some specific sequence?

(a) AEIOU   (b) ACEGI   (c) ACJEI   (d) AEIMO   (e) AJKLT

(76) If + means ×, - means + and × means ÷ find the value of

$5 + 4 - 18 \times 3 = ?$

(a) – 34   (b) 6   (c) 26   (d) 15   (e) 14

(77) If + means ÷, × means -, ÷ means × and - means +, then

$8 + 6 \times 4 \div 3 - 4 = ?$

(a) -12   (b) $-\dfrac{20}{3}$ (c) 12   (d) $\dfrac{20}{3}$ (e) None of these

(78) If × means ÷, - means ×, ÷ means + and + means -, then

$(3 - 15 \div 19) \times 8 + 6 = ?$

(a) 8   (b) 4   (c) 2   (d) -1   (e) None of these

(79) If $\times$ means $+$, $\div$ means $-$, $-$ means $\times$ and $+$ means $\div$,

$8 \times 7 - 8 + 40 \div 2 = ?$

(a) 1   (b) $7\dfrac{2}{5}$ (c) $8\dfrac{3}{5}$ (d) 44   (e) None of these

(80) If $-$ stands for $+$, $+$ for $\times$, $\div$ for $-$ and $\times$ for $\div$ which one of the following equation
    is wrong.

(a) $5 - 2 + 12 \times 6 \div 2 = 27$ (b) $5 + 2 - 12 \div 6 \times 2 = 13$

(c) $5 + 2 - 12 \times 6 \div 2 = 10$ (d) $5 \div 2 + 12 \times 6 - 2 = 3$

(81) If P denotes $\div$, Q denotes $\times$,R denotes $+$, and S denotes $-$ then

$18 \, Q \, 12 \, P \, 4 \, R \, 5 \, S \, 6 = ?$

(a) 36   (b) 53   (c) 34   (d) 65   (e) 59

In the following questions , when interchanges are made in signs and numbers, which one of the four equations would be correct?

    Interchange
(82) Signs $+$ and $\div$ and Number 2 and 4.

(a) $2 + 4 \div 3 = 3.0$ (b) $4 + 2 \div 6 = 1.5$

(c) $4 \div 2 + 3 = 4.0$ (d) $2 + 4 \div 6 = 8.0$

    Interchange
(83) Signs $-$ and $\div$ and Numbers 4 and 8

(a) $6 - 8 \div 4 = - 1.0$ (b) $8 - 6 \div 4 = 1.0$

(c) $4 \div 8 - 2 = 6.0$ (d) $4 - 8 \div 6 = 2.0$

Interchange
(84) Signs + and × and numbers 4 and 5

(a) $5 \times 4 + 20 = 40$

(b) $5 \times 4 \div 20 = 85$

(c) $5 \times 4 + 20 = 104$

(d) $5 \times 4 \div 20 = 85$

Interchange:
(85) Signs + and − and Numbers 4 and 8

(a) $4 \div 8 − 12 = 16$

(b) $4 − 8 + 12 = 0$

(c) $8 \div 4 − 12 = 24$

(d) $8 − 4 \div 12 = 8$

Interchange
(86) Signs − and × and Numbers 3 and 6

(a) $6 − 3 \times 2 = 9$

(b) $3 − 6 \times 8 = 10$

(c) $6 \times 3 − 4 = 15$

(d) $3 \times 6 − 4 = 33$

In the following questions, which one of the four interchanges in signs and numbers would make the given equation correct.

(87) $3 + 5 − 2 = 4$

(a) + and - , 2 and 3
(c) + and - , 3 and 5

(b) + and - , 2 and 5
(d) None of the above.

(88) $6 \times 4 + 2 = 16$
(a) + and × , 2 and 4
(c) + and ×, 4 and 6

(b) + and × , 2 and 6
(d) None of the above

(89) $(3 \div 4) + 2 = 2$

(a) + and ÷, 2 and 3
(c) + and ÷, 3 and 4

(b) + and ÷, 2 and 4
(d) No interchange, 3 and 4

(90) If $\cap$ stands for +

$\subset$ stands for −

$\supset$ stands for ×

$\cup$ stands for ÷

$\parallel$ stands for =

$\rightarrow$ stands for >

Which one of the following expression is true?

(a) $(10 \cap 2) \supset (2 \parallel 2) \leftarrow (10 \cup 2)$ (b) $(20 \subset 8) \cup (4 \subset 1) \parallel (4 \cap 1)$

(c) $(12 \subset 4) \supset (5 \supset 1) \leftarrow (10 \cap 20)$ (d) $(10 \cap 2) \supset (2 \cup 2) \rightarrow (10 \cup 2)$

(e) $(18 \cup 3) \subset (3 \cap 1) \cap (5 \parallel 20)$

Rahul is five years old and Sohan is nine. Answer the following questions from No. 91 to 94 based on this information.

(91) How old was Sohan when he was twice as old as Rahul?

(a) 7   (b) 8   (c) 10   (d) 15

(92) How old was Rahul when Sohan was three times as old as him?

(a) 9   (b) 14   (c) 16   (d) 12

(93) In how many years will their ages when added make it 24 ?

(a) 7   (b) 6   (c) 5   (d) 8

(94) In how many years time will Rahul be twice as old as Sohan was when he himself was three ?

(a) 7   (b) 10   (c) 14   (d) 9

A number of small wooden cubes, each with an edge of one inch, are stuck together to form a solid cube of edge 4 inches. The big cube is then marked on each face by straight lines forming a cross, the lines being drawn from corner to corner. Answer the following questions from No. 95 to 97 based on this information.

(95) How many little cubes have no face exposed on the surface of the big cube?

(a) 8   (b) 6   (c) 4   (d) 10

(96) How many little cubes are marked on two faces only?

(a) 6   (b) 4   (c) 8   (d) 10

(97) How many little cubes are marked on three faces only?

(a) 4   (b) 6   (c) 14   (d) 8

(98) Anuj is the son of Ram. Seema, Ram's sister has a son Sonu and daughter Reena. Raja is the maternal uncle of Sonu.
How many nephews does Raja have?

(a) 1   (b) 2   (c) 3   (d) 4   (e) None

(99) Five friends, M, P, Q, N and O are sitting on a bench in the following order:-

- O is sitting next to M and P is next to Q.
- Q is not sitting with N, N is on the extreme left hand side of the bench and P is on second position from right hand side.
- O is on the right hand side of M and to the right side of N.
- O and P are sitting together.

Who is sitting in the middle?

(a) O   (b) Q   (c) M   (d) P   (e) N

(100) Rampur is located between Hamidnagar and Solan. Hamidnagar is located between Mohannagar and Solan. Therefore, which one of the following statements is correct?

(a) Rampur is not between Mohannagar and Solan.

(b) Rampur is between Hamidnagar and Mohannagar.

(c) Rampur is nearer to Hamidnagar than to Mohannagar.

(d) Rampur is nearer to Hamidnagar than to Solan.

(e) Solan is nearer to Hamidnagar than to Rampur.

MENTAL ABILITY TEST
(NON-VERBAL)

MENTAL ABILITY TEST

INSTRUCTIONS:

1. This is a test of your ability to solve problems quickly and correctly. Try to do as many problems as possible. Do your best.

2. All your answers must be recorded on the answer sheet provided to you along with the booklet. DO NOT MARK THIS BOOKLET IN ANY WAY. Write your answers in the appropriate column for answers against the relevant problem number.

3. Give only ONE ANSWER to each problem. If you wish to alter or amend your answer on the answer sheet, cross the one you have already put and write the new answer legibly.

4. If you find any problem too difficult, proceed to the next. Do not waste time on the difficult problems. You may return to the left out problems after finishing the test.

5. No questions about the test will be answered after the testing begins.

6. A few illustrations of the type of questions that you will find in the test are given on the next page.

169

EXAMPLE-1

Instruction: Out of the five figures A, B, C, D and E given below four figures are similar in one way. However, one figure is not like the other four. Choose the figure which is different from the rest.

Solution: Except in figure (A), in all other figures the two arrows point in different directions. The arrows in figure (A) point in the same direction and hence the figure (A) is different from the other four. Figure (A) is therefore the correct answer and is written against example '1' on your answer sheet.

EXAMPLE-2

Instruction: Write the correct choice of the figure which would be required to continue with the series.

Problem Figures   Answer Figures

Solution: In the problem figures, one petal gets added to the flower in a serial order starting from one petal in the 1st figure to five petals in the 5th figure. The figure that should continue the series, therefore, should have six petals. Choice (C) is the correct answer and is written against example '2' on your answer sheet.

EXAMPLE-3

Instruction: In this example, figure 'W' has some relationship with figure 'X'. Figure 'Y' has the same relationship with one of the five choice figures namely A, B, C, D & E. You are required to find out the correct answer and write the correct choice on the answer sheet.

Problem Set

Answer Set

W   X   Y   Z

A   B   C   D   E

Solution: When one sees the problem figures one finds that figure X consists of the same figure as figure W and also its mirror image. Similarly, figure Y should be followed by a choice which has both the figure Y as well as its mirror image. Looking at the answer figures one sees that choice (C) fulfils the condition and hence choice (C) is the correct answer and is written against example '3' on your answer sheet.

EXAMPLE-4

Instruction: This part of test involves the problems relating to the counting of geometrical figures in a given complex figure. Study the geometrical figure carefully and write the choice of your answer in the answer sheet.

Example: How many number of straight lines are there in the following figure?

(A) 11 (C) 16
(B) 17 (D) 14

Solution: The figure is labeled as shown.
There are three horizontal lines namely AE, LF, & KG.
There are five vertical lines: AK, BJ, CI, DH and EG.
There are six slanting lines: LC, KE, IF, LI, AG and CF.
Thus there are 3+5+6=14 straight lines in the figure.
Therefore, choice (D) is the correct answer and is written against example '4' on your answer sheet.

EXAMPLE-5

Instructions: In each of the following questions, choose the correct mirror image of the figure X from amongst the four alternatives (A), (B), (C) and (D) given along with it.

(X)   (A)   (B)   (C)   (D)

Solution: In a mirror image the right side of the object appears on the left side and vice versa. The above figure (X) when seen in a mirror the half circle on top left corner will appear on top right corner and the triangle on bottom right will appear on bottom left. Therefore, choice (B) is the correct answer and is written against example '5' on the answer sheet.

EXAMPLE-6

Instruction: Write the choice of the correct figure which will complete the design shown in figure X.

X   A   B   C   D

Solution: The figure X has a part of the pattern which is missing. On closer look at the choice figures one sees that figure in choice (B) when added to the figure X would complete the figure. Hence, choice (B) is the correct answer and is written against example 6 on the answer sheet.

<u>EXAMPLE-7</u>

<u>Instruction:</u>: The problem figure, P, is hidden in one of the figures shown in the choice figures A, B, C & D. Find the figure (P) and write the correct choice on your answer sheet.

<u>Solution:</u> On closer look you will find that the figure (P) is hidden in choice (A) and cannot be identified in the other choice figures. Choice (A) is, therefore, the correct answer and is written against example 7 on your answer sheet.

You will get similar problems in the test. In all, there are 100 problems to be solved in this test.

DO NOT TURN OVER THE PAGE UNLESS ASKED TO DO SO

THE TEST
(NON-VERBAL)

Instructions: Out of the five figures (A), (B), (C), (D) and (E) given in each problem four are similar in one way. However, one figure is not like the other four. Choose the figure which is different from the rest.

1.
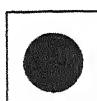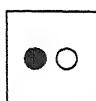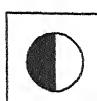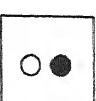
A	B	C	D	E

2.
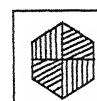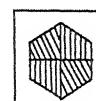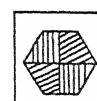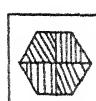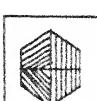
A	B	C	D	E

3.
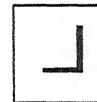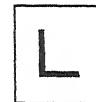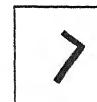
A	B	C	D	E

4.

A	B	C	D	E

5.

A	B	C	D	E

Instructions: Out of the five figures (A), (B), (C), (D) and (E) given in each problem four are similar in one way. However, one figure is not like the other four. Choose the figure which is different from the rest.

6.

A   B   C   D   E

7.

A   B   C   D   E

8.

A   B   C   D   E

9.

A   B   C   D   E

10.

A   B   C   D   E

11.

A   B   C   D   E

12.

A   B   C   D   E

13.

A   B   C   D   E

14.

A   B   C   D   E

15.

A   B   C   D   E

Instructions: Out of the five figures (A), (B), (C), (D) and (E) given in each problem four are similar in one way. However, one figure is not like the other four. Choose the figure which is different from the rest.

16.

A   B   C   D   E

17.

A   B   C   D   E

18.

A   B   C   D   E

19.

A   B   C   D   E

20.

A   B   C   D   E

Instructions: Each of the following questions consists of figures called problem figures which are followed by other figures called answer figures. Select the figures from amongst the answer figures which will continue the same series as established by the problem figures.

Problem Figures

21.

1	2	3	4
□	■	○	?

Answer Figures

A	B	C	D
■	●	○	▲

Problem Figures

22.

1	2	3	4
⊕	⊕	⊕	?

Answer Figures

A	B	C	D

Problem Figures

23.

1	2	3	4
○	◓	●	▭

Answer Figures

A	B	C	D

Problem Figures

24.

1	2	3	4

Answer Figures

A	B	C	D

Problem Figures

25.

1	2	3	4

Answer Figures

A	B	C	D

Instructions: Each of the following questions consists of figures called problem figures
which are followed by other figures called answer figures. Select the figures from amongst
the answer figures which will continue the same series as established by the problem figures.

Problem Figures

26.

1   2   3   4

Answer Figures

A   B   C   D

Problem Figures

27.

1   2   3   4

Answer Figures

A   B   C   D

Problem Figures

28.

1   2   3   4

Answer Figures

A   B   C   D

Problem Figures

29.

1   2   3   4

Answer Figures

A   B   C   D

Problem Figures

30.

1   2   3   4

Answer Figures

A   B   C   D

31.

Problem Figures

1   2   3   4

Answer Figures

A   B   C   D

32.

Problem Figures

1   2   3   4

Answer Figures

A   B   C   D

33.

Problem Figures

1   2   3   4   5

Answer Figures

A   B   C   D   E

34.

Problem Figures

1   2   3   4   5

Answer Figures

A   B   C   D   E

35.

Problem Figures

1   2   3   4   5

Answer Figures

A   B   C   D   E

Instructions: Each of the following questions consists of figures called problem figures which are followed by other figures called answer figures. Select the figures from amongst the answer figures which will continue the same series as established by the problem figures.

36.

Problem Figures

Answer Figures

37.

Problem Figures

Answer Figures

38.

Problem Figures

Answer Figures

39.

Problem Figures

Answer Figures

40.

Problem Figures

Answer Figures

Instructions: Write the choice of the correct figure which will complete the design.

41.

A   B   C   D

42.

A   B   C   D

Instructions: Write the choice of the correct figure which will complete the design.

43.

A	B	C	D

44.

A	B	C	D

45.

A   B   C   D

46.

A   B   C   D

47.

A   B   C   D

48.

B   C   D

49.

A	B	C	D

50.

A	B	C	D

51.

A   B   C   D

52.

A   B   C   D

53.

A   B   C   D

54.

A   B   C   D

55.

A   B   C   D

56.

A   B   C   D

57.

A   B   C   D

58.

A   B   C   D

59.

A   B   C   D

60.

A   B   C   D

Instructions: Each of the following questions consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

Problem Set — **Answer Set**

61.

W   X   Y   Z   A   B   C   D   E

Problem Set — **Answer Set**

62.

W   X   Y   Z   A   B   C   D   E

Problem Set — **Answer Set**

63.

W   X   Y   Z   A   B   C   D   E

Problem Set — **Answer Set**

64.

W   X   Y   Z   A   B   C   D   E

Problem Set — **Answer Set**

65.

W   X   Y   Z   A   B   C   D   E

Instructions: Each of the following questions consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

66.

Problem Set	Answer Set

W   X   Y   Z   A   B   C   D   E

67.

Problem Set	Answer Set

W   X   Y   Z   A   B   C   D   E

68.

Problem Set	Answer Set

W   X   Y   Z   A   B   C   D   E

69.

Problem Set	Answer Set

W   X   Y   Z   A   B   C   D   E

70.

Problem Set	Answer Set

W   X   Y   Z   A   B   C   D   E

Instructions: Each of the following questions consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

71.

Problem Set

Answer Set

72.

Problem Set

Answer Set

73.

Problem Set

Answer Set

74.

Problem Set

Answer Set

75.

Problem Set

Answer Set

76.

Problem Set

Answer Set

W   X   Y   Z   A   B   C   D   E

77.

Problem Set

Answer Set

W   X   Y   Z   A   B   C   D   E

78.

Problem Set

Answer Set

W   X   Y   Z   A   B   C   D   E

79.

Problem Set

Answer Set

W   X   Y   Z   A   B   C   D   E

80.

Problem Set

Answer Set

W   X   Y   Z   A   B   C   D   E

Instructions: Each of the following questions consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

81.

Problem Set

| W | X | Y | Z |

Answer Set

| A | B | C | D | E |

82.

Problem Set

| W | X | Y | Z |

Answer Set

| A | B | C | D | E |

83.

Problem Set

| W | X | Y | Z |

Answer Set

| A | B | C | D | E |

84.

Problem Set

| W | X | Y | Z |

Answer Set

| A | B | C | D | E |

85.

Problem Set

| W | X | Y | Z |

Answer Set

| A | B | C | D | E |

Instructions: In the following questions, choose the correct mirror image of the figure X from amongst the four alternatives (A), (B), (C) and (D) given alongwith it.
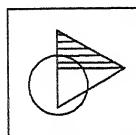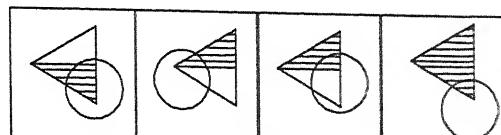
86. X   A   B   C   D
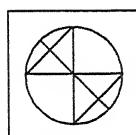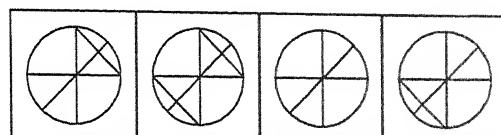
87. X   A   B   C   D
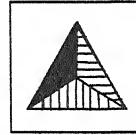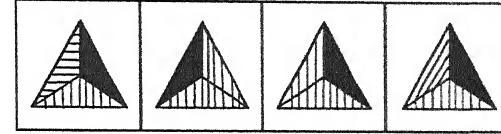
88. X   A   B   C   D

89. X   A   B   C   D

90. X   A   B   C   D

91. P | A B C D

92. P | A B C D

93. P | A B C D

94. P | A B C D
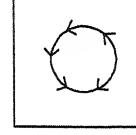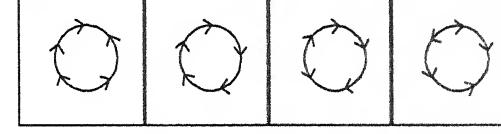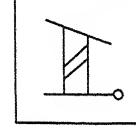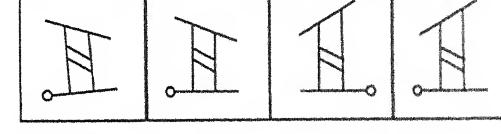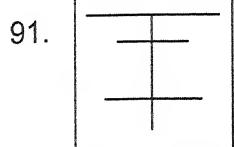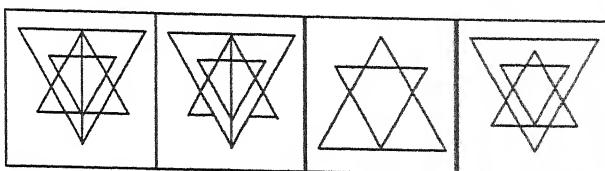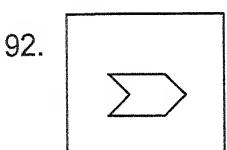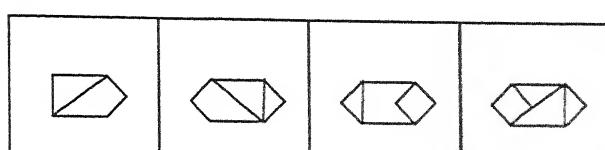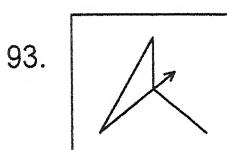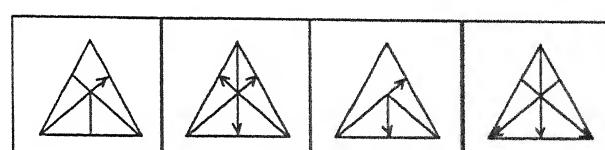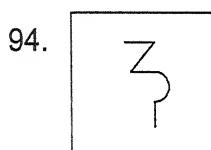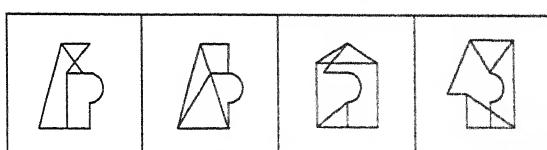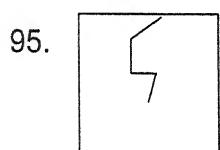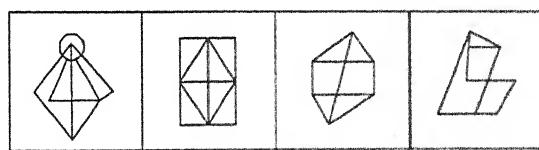
95. P | A B C D

96. Count the number of triangles in the following figure
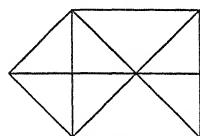
(A) 15   (C) 17   (E) 18

(B) 16   (D) 19

97. Count the number of rectangles in the following figure:
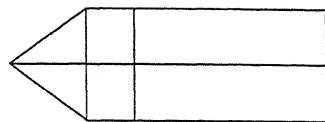
(A) 6   (C) 8   (E) 5

(B) 7   (D) 9

Study the following figure and answer questions 98 to 100.
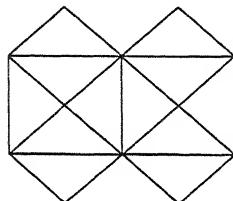
98. What is the minimum number of straight lines that is needed to construct the figure.

(A) 11   (B) 18   (C) 13   (D) 15   (E) 21

99. Count the number of triangles in the figure.

(A) 20   (B) 24   (C) 22   (D) 16   (E) 12

100. Count the number of squares in the figure.

(A) 5   (B) 6   (C) 7   (D) 8   (E) 9

= = = = ***= = = =

Difficulty and Discrimination indices of Verbal Mental Ability Test

Item No.	p.	q.	pq.	sqrtpq	rptbi	S/NS
ITEM1	0.9286	0.0714	0.0663	0.2575	0.1417	NS
ITEM2	0.9286	0.0714	0.0663	0.2575	0.1115	NS
ITEM3	0.4857	0.5143	0.2498	0.4998	0.2557	S
ITEM4	0.6214	0.3786	0.2353	0.4850	0.0816	NS
ITEM5	0.6214	0.3786	0.2353	0.4850	0.0874	NS
ITEM6	0.6000	0.4000	0.2400	0.4899	0.0660	NS
ITEM7	0.9714	0.0286	0.0278	0.1666	0.0245	NS
ITEM8	0.6000	0.4000	0.2400	0.4899	0.2062	S
ITEM9	0.5429	0.4571	0.2482	0.4982	0.0173	NS
ITEM10	0.9571	0.0429	0.0410	0.2025	0.0631	NS
ITEM11	0.9714	0.0286	0.0278	0.1666	0.1023	NS
ITEM12	0.9643	0.0357	0.0344	0.1856	0.0878	NS
ITEM13	0.7071	0.2929	0.2071	0.4551	0.3204	NS
ITEM14	0.7143	0.2857	0.2041	0.4518	0.2850	NS
ITEM15	0.6500	0.3500	0.2275	0.4770	0.3387	S
ITEM16	0.5857	0.4143	0.2427	0.4926	0.0977	NS
ITEM17	0.0429	0.9571	0.0410	0.2025	0.0330	NS
ITEM18	0.8214	0.1786	0.1467	0.3830	0.0459	NS
ITEM19	0.8857	0.1143	0.1012	0.3182	0.1444	NS
ITEM20	0.6286	0.3714	0.2335	0.4832	0.2056	S
ITEM21	0.4214	0.5786	0.2438	0.4938	0.2005	S
ITEM22	0.9286	0.0714	0.0663	0.2575	0.0834	NS

ITEM23	0.8286	0.1714	0.1420	0.3769	0.2536	NS
ITEM24	0.2857	0.7143	0.2041	0.4518	0.0731	NS
ITEM25	0.9071	0.0929	0.0842	0.2902	0.233	NS
ITEM26	0.7929	0.2071	0.1642	0.4053	0.2308	NS
ITEM27	0.8143	0.1857	0.1512	0.3889	0.1519	NS
ITEM28	0.7071	0.2929	0.2071	0.4551	0.1408	NS
ITEM29	0.6500	0.3500	0.2275	0.4770	0.2060	S
ITEM30	0.8714	0.1286	0.1120	0.3347	0.0150	NS
ITEM31	0.6714	0.3286	0.2206	0.4697	0.2007	S
ITEM32	0.8929	0.1071	0.0957	0.3093	0.2642	NS
ITEM33	0.9143	0.0857	0.0784	0.2799	0.2164	NS
ITEM34	0.9000	0.1000	0.0900	0.3000	0.3063	NS
ITEM35	0.9429	0.0571	0.0539	0.2321	0.2906	NS
ITEM36	0.9286	0.0714	0.0663	0.2575	0.2907	NS
ITEM37	0.8857	0.1143	0.1012	0.3182	0.2405	NS
ITEM38	0.6286	0.3714	0.2335	0.4832	0.2549	S
ITEM39	0.1857	0.8143	0.1512	0.3889	0.1840	NS
ITEM40	0.6286	0.3714	0.2335	0.4832	0.2052	S
ITEM41	0.7143	0.2857	0.2041	0.4518	0.3059	NS
ITEM42	0.0571	0.9429	0.0539	0.2321	0.0894	NS
ITEM43	0.6500	0.3500	0.2275	0.4770	0.3165	S
ITEM44	0.4571	0.5429	0.2482	0.4982	0.2494	S
ITEM45	0.5000	0.5000	0.2500	0.5000	0.4409	S
ITEM46	0.0571	0.9429	0.0539	0.2321	0.0750	NS
ITEM47	0.8357	0.1643	0.1373	0.3705	0.2975	NS
ITEM48	0.7857	0.2143	0.1684	0.4103	0.4132	NS

ITEM49	0.8071	0.1929	0.1557	0.3945	0.2648	NS
ITEM50	0.6857	0.3143	0.2155	0.4642	0.2122	S
ITEM51	0.6643	0.3357	0.2230	0.4722	0.5053	S
ITEM52	0.7571	0.2429	0.1839	0.4288	0.4027	NS
ITEM53	0.6786	0.3214	0.2181	0.4670	0.3927	S
ITEM54	0.8929	0.1071	0.0957	0.3093	0.3451	NS
ITEM55	0.7857	0.2143	0.1684	0.4103	0.2506	NS
ITEM56	0.8643	0.1357	0.1173	0.3425	0.2867	NS
ITEM57	0.3929	0.6071	0.2385	0.4884	0.3181	S
ITEM58	0.6786	0.3214	0.2181	0.4670	0.4189	S
ITEM59	0.6786	0.3214	0.2181	0.4670	0.4380	S
ITEM60	0.7500	0.2500	0.1875	0.4330	0.4946	NS
ITEM61	0.8143	0.1857	0.1512	0.3889	0.5479	NS
ITEM62	0.7643	0.2357	0.1802	0.4244	0.4597	NS
ITEM63	0.7929	0.2071	0.1642	0.4053	0.5203	NS
ITEM64	0.5857	0.4143	0.2427	0.4926	0.6123	S
ITEM65	0.6071	0.3929	0.2385	0.4884	0.4844	S
ITEM66	0.6500	0.3500	0.2275	0.4770	0.3165	NS
ITEM67	0.7786	0.2214	0.1724	0.4152	0.5605	NS
ITEM68	0.6643	0.3357	0.2230	0.4722	0.3252	S
ITEM69	0.7214	0.2786	0.2010	0.4483	0.4687	NS
ITEM70	0.6857	0.3143	0.2155	0.4642	0.5164	S
ITEM71	0.6714	0.3286	0.2206	0.4697	0.5605	S
ITEM72	0.5857	0.4143	0.2427	0.4926	0.4645	S
ITEM73	0.5714	0.4286	0.2449	0.4949	0.5829	S
ITEM74	0.6071	0.3929	0.2385	0.4884	0.5151	S

ITEM75	0.4500	0.5500	0.2475	0.4975	0.3913	S
ITEM76	0.6000	0.4000	0.2400	0.4899	0.4871	S
ITEM77	0.4000	0.6000	0.2400	0.4899	0.5014	S
ITEM78	0.4571	0.5429	0.2482	0.4982	0.3800	S
ITEM79	0.3786	0.6214	0.2353	0.4850	0.5293	S
ITEM80	0.1357	0.8643	0.1173	0.3425	0.2522	NS
ITEM81	0.4214	0.5786	0.2438	0.4938	0.5447	S
ITEM82	0.3500	0.6500	0.2275	0.4770	0.3700	S
ITEM83	0.3000	0.7000	0.2100	0.4583	0.4915	S
ITEM84	0.3286	0.6714	0.2206	0.4697	0.4882	S
ITEM85	0.2714	0.7286	0.1978	0.4447	0.5298	NS
ITEM86	0.3286	0.6714	0.2206	0.4697	0.4598	S
ITEM87	0.2143	0.7857	0.1684	0.4103	0.3226	NS
ITEM88	0.3071	0.6929	0.2128	0.4613	0.4127	S
ITEM89	0.2857	0.7143	0.2041	0.4518	0.4854	NS
ITEM90	0.1500	0.8500	0.1275	0.3571	0.4547	NS
ITEM91	0.2714	0.7286	0.1978	0.4447	0.3460	NS
ITEM92	0.1143	0.8857	0.1012	0.3182	0.1369	NS
ITEM93	0.3714	0.6286	0.2335	0.4832	0.3929	S
ITEM94	0.2071	0.7929	0.1642	0.4053	0.2740	NS
ITEM95	0.1571	0.8429	0.1324	0.3639	0.2725	NS
ITEM96	0.0786	0.9214	0.0724	0.2691	0.2638	NS
ITEM97	0.1643	0.8357	0.1373	0.3705	0.2967	NS
ITEM98	0.1714	0.8286	0.1420	0.3769	0.1948	NS
ITEM99	0.2143	0.7857	0.1684	0.4103	0.4594	NS
ITEM100	0.3286	0.6714	0.2206	0.4697	0.4101	S

Appendix-IV

Difficulty and Discrimination indices of Non-verbal Mental Ability Test

Item Nos.	p.	q.	pq.	sqrtpq	Rptbi	S/NS
ITEM1	0.9712	0.0288	0.0279	0.1672	0.1754	NS
ITEM2	0.8221	0.1704	0.1512	0.3889	0.2516	NS
ITEM3	0.3309	0.6691	0.2214	0.4705	0.2052	S
ITEM4	0.0072	0.9928	0.0071	0.0845	0.0627	NS
ITEM5	0.9209	0.0791	0.0729	0.2700	0.1651	NS
ITEM6	0.9424	0.0576	0.0542	0.2329	0.1740	NS
ITEM7	0.3957	0.6043	0.2391	0.4890	0.2078	S
ITEM8	0.0216	0.9784	0.0211	0.1453	0.1395	NS
ITEM9	0.8777	0.1223	0.1073	0.3276	0.2064	NS
ITEM10	0.0791	0.9209	0.0729	0.2700	0.1697	NS
ITEM11	0.7770	0.2230	0.1733	0.4163	0.1200	NS
ITEM12	0.0504	0.9496	0.0478	0.2187	0.0475	NS
ITEM13	0.3309	0.6691	0.2214	0.4705	0.1091	NS
ITEM14	0.9281	0.0719	0.0668	0.2584	0.1326	NS
ITEM15	0.3094	0.6906	0.2137	0.4622	0.2235	NS
ITEM16	0.2446	0.7554	0.1848	0.4299	0.1695	NS
ITEM17	0.6763	0.3237	0.2189	0.4679	0.1305	NS
ITEM18	0.6619	0.3381	0.2238	0.4731	0.1211	NS
ITEM19	0.9065	0.0935	0.0848	0.2912	0.3375	NS
ITEM20	0.3885	0.6115	0.2376	0.4874	0.2602	S
ITEM21	0.9712	0.0288	0.0279	0.1672	0.3025	NS
ITEM22	0.9784	0.0216	0.0211	0.1453	0.3116	NS

ITEM23	0.9281	0.0719	0.0668	0.2584	0.1810	NS
ITEM24	0.8993	0.1007	0.0906	0.3010	0.2611	NS
ITEM25	0.6115	0.3885	0.2376	0.4874	0.2244	S
ITEM26	0.8921	0.1079	0.0963	0.3103	0.2402	NS
ITEM27	0.9281	0.0719	0.0668	0.2584	0.1108	NS
ITEM28	0.8273	0.1727	0.1428	0.3780	0.3581	NS
ITEM29	0.6978	0.3022	0.2109	0.4592	0.3052	S
ITEM30	0.6115	0.3885	0.2376	0.4874	0.2067	S
ITEM31	0.5683	0.4317	0.2453	0.4953	0.0302	NS
ITEM32	0.6835	0.3165	0.2163	0.4651	0.1978	S
ITEM33	0.0576	0.9424	0.0542	0.2329	0.0326	NS
ITEM34	0.6835	0.3165	0.2163	0.4651	0.2905	S
ITEM35	0.0647	0.9353	0.0606	0.2461	0.1228	NS
ITEM36	0.8345	0.1655	0.1381	0.3716	0.2120	NS
ITEM37	0.0576	0.9424	0.0542	0.2329	0.0506	NS
ITEM38	0.0935	0.9065	0.0848	0.2912	0.0564	NS
ITEM39	0.9424	0.0576	0.0542	0.2329	0.2223	NS
ITEM40	0.7410	0.2590	0.1919	0.4381	0.2744	NS
ITEM41	0.8417	0.1583	0.1332	0.3650	0.2168	NS
ITEM42	0.6906	0.3094	0.2137	0.4622	0.2086	S
ITEM43	0.9353	0.0647	0.0606	0.2461	0.1634	NS
ITEM44	0.9353	0.0647	0.0606	0.2461	0.1304	NS
ITEM45	0.8129	0.1871	0.1521	0.3900	0.3086	NS
ITEM46	0.6259	0.3741	0.2341	0.4839	0.2610	S
ITEM47	0.1799	0.8201	0.1475	0.3841	0.1626	NS
ITEM48	0.8417	0.1583	0.1332	0.3650	0.3726	NS

ITEM49	0.6475	0.3525	0.2282	0.4778	0.2232	S
ITEM50	0.7554	0.2446	0.1848	0.4299	0.2928	NS
ITEM51	0.5827	0.4173	0.2432	0.4931	0.2610	S
ITEM52	0.4604	0.5396	0.2484	0.4984	0.2597	S
ITEM53	0.7410	0.2590	0.1919	0.4381	0.4385	NS
ITEM54	0.7842	0.2158	0.1692	0.4114	0.3592	NS
ITEM55	0.7266	0.2734	0.1986	0.4457	0.2346	NS
ITEM56	0.4676	0.5324	0.2490	0.4990	0.1298	NS
ITEM57	0.4604	0.5396	0.2484	0.4984	0.3174	S
ITEM58	0.3022	0.6978	0.2109	0.4592	0.3372	S
ITEM59	0.5612	0.4388	0.2463	0.4962	0.3607	S
ITEM60	0.4101	0.5899	0.2419	0.4918	0.4073	S
ITEM61	0.6835	0.3165	0.2163	0.4651	0.4222	S
ITEM62	0.7194	0.2806	0.2019	0.4493	0.3530	NS
ITEM63	0.6475	0.3525	0.2282	0.4778	0.4181	S
ITEM64	0.6763	0.3237	0.2189	0.4679	0.3148	S
ITEM65	0.7698	0.2302	0.1772	0.4210	0.3970	NS
ITEM66	0.7986	0.2014	0.1609	0.4011	0.4526	NS
ITEM67	0.8058	0.1942	0.1565	0.3956	0.4960	NS
ITEM68	0.6978	0.3022	0.2109	0.4592	0.4998	S
ITEM69	0.7626	0.2374	0.1810	0.4255	0.5315	NS
ITEM70	0.7914	0.2086	0.1651	0.4063	0.5613	NS
ITEM71	0.5252	0.4748	0.2494	0.4994	0.4303	S
ITEM72	0.7842	0.2158	0.1692	0.4114	0.5628	NS
ITEM73	0.3669	0.6331	0.2323	0.4820	0.4116	S
ITEM74	0.7122	0.2878	0.2050	0.4527	0.6575	NS

ITEM75	0.7482	0.2518	0.1884	0.4340	0.5628	NS
ITEM76	0.5252	0.4748	0.2494	0.4994	0.3352	S
ITEM77	0.3957	0.6043	0.2391	0.4890	0.4952	S
ITEM78	0.3094	0.6906	0.2137	0.4622	0.4695	S
ITEM79	0.5899	0.4101	0.2419	0.4918	0.5139	S
ITEM80	0.4245	0.5755	0.2443	0.4943	0.4850	S
ITEM81	0.4892	0.5108	0.2499	0.4999	0.3253	S
ITEM82	0.6187	0.3813	0.2359	0.4857	0.5205	S
ITEM83	0.1583	0.8417	0.1332	0.3650	0.0507	NS
ITEM84	0.1583	0.8417	0.1332	0.3650	0.0743	NS
ITEM85	0.2302	0.7698	0.1772	0.4210	0.2072	NS
ITEM86	0.5396	0.4604	0.2484	0.4984	0.3208	S
ITEM87	0.6259	0.3741	0.2341	0.4839	0.4069	S
ITEM88	0.5612	0.4388	0.2463	0.4962	0.4753	S
ITEM89	0.1727	0.8273	0.1428	0.3780	0.0272	NS
ITEM90	0.5468	0.4532	0.2478	0.4978	0.4323	S
ITEM91	0.6043	0.3957	0.2391	0.4890	0.3956	S
ITEM92	0.5036	0.4964	0.2500	0.5000	0.5315	S
ITEM93	0.5396	0.4604	0.2484	0.4984	0.4336	S
ITEM94	0.5899	0.4101	0.2419	0.4918	0.3500	S
ITEM95	0.5180	0.4820	0.2497	0.4997	0.4018	S
ITEM96	0.1799	0.8201	0.1475	0.3841	0.1740	NS

ITEM97	0.1942	0.8058	0.1565	0.3956	0.0489	NS
ITEM98	0.2806	0.7194	0.2019	0.4493	0.3856	NS
ITEM99	0.1871	0.8129	0.1521	0.3900	0.1770	NS
ITEM100	0.3957	0.6043	0.2391	0.4890	0.2997	S

Verbal Mental Ability Test (Final) as per graded difficulty Level
(40 items)

NEW ITEM No.	P	q	rptbi	OLD ITEM No.
1	0.69	0.31	0.51	70
2	0.69	0.31	0.21	50
3	0.68	0.32	0.43	59
4	0.68	0.32	0.41	58
5	0.68	0.32	0.39	53
6	0.67	0.33	0.56	71
7	0.67	0.33	0.20	31
8	0.66	0.34	0.50	51
9	0.66	0.34	0.33	68
10	0.65	0.35	0.34	15
11	0.65	0.35	0.31	43
12	0.65	0.35	0.31	66
13	0.65	0.35	0.20	29
14	0.63	0.37	0.25	38
15	0.63	0.37	0.20	40
16	0.63	0.37	0.20	20
17	0.61	0.39	0.51	74
18	0.61	0.39	0.48	65
19	0.60	0.40	0.48	76
20	0.60	0.40	0.20	8
21	0.59	0.41	0.46	72
22	0.58	0.42	0.61	64
23	0.57	0.43	0.58	73
24	0.50	0.50	0.44	45
25	0.49	0.51	0.26	3
26	0.46	0.54	0.25	44
27	0.46	0.54	0.38	78
28	0.45	0.55	0.39	75
29	0.42	0.58	0.54	81
30	0.42	0.58	0.20	21
31	0.40	0.60	0.50	77
32	0.39	0.61	0.32	57
33	0.38	0.62	0.53	79
34	0.37	0.63	0.39	93
35	0.35	0.65	0.37	82
36	0.33	0.67	0.49	84
37	0.33	0.67	0.46	86
38	0.33	0.67	0.41	100
39	0.30	0.7	0.49	83
40	0.30	0.70	0.41	88

Non-Verbal Mental Ability Test (Final) as per graded difficulty level
(40 items)

NEW ITEM No.	p	q	rptbi	OLD ITEM N0.
1	0.70	0.30	0.50	68
2	0.70	0.30	0.30	29
3	0.69	0.31	0.20	42
4	0.68	0.32	0.42	61
5	0.68	0.32	0.31	64
6	0.68	0.32	0.29	34
7	0.68	0.32	0.20	32
8	0.65	0.35	0.42	63
9	0.65	0.35	0.22	49
10	0.63	0.37	0.41	87
11	0.63	0.37	0.26	46
12	0.62	0.38	0.52	82
13	0.61	0.39	0.22	25
14	0.61	0.39	0.20	30
15	0.60	0.40	0.40	91
16	0.60	0.40	0.35	94
17	0.59	0.41	0.51	79
18	0.58	0.42	0.26	51
19	0.56	0.44	0.48	88
20	0.56	0.44	0.36	59
21	0.55	0.45	0.43	90
22	0.54	0.46	0.43	93
23	0.54	0.46	0.32	86
24	0.53	0.47	0.33	76
25	0.52	0.48	0.43	71
26	0.52	0.48	0.40	95
27	0.50	0.50	0.53	92
28	0.49	0.51	0.33	81
29	0.46	0.54	0.32	57
30	0.46	0.54	0.26	52
31	0.42	0.58	0.49	80
32	0.41	0.59	0.41	60
33	0.40	0.60	0.50	77
34	0.40	0.60	0.30	100
35	0.40	0.60	0.20	7
36	0.39	0.61	0.26	20
37	0.37	0.63	0.41	73
38	0.33	0.67	0.20	3
39	0.31	0.69	0.47	78
40	0.31	0.69	0.34	58

FINAL
MENTAL ABILITY TEST
(VERBAL)

MENTAL ABILITY TEST

INSTRUCTIONS:

1. This is a test of your ability to solve problems quickly and correctly. Try to do as many problems as possible. Do your best.

2. All your answers must be recorded on the answer sheet provided to you along with the booklet. DO NOT MARK THIS BOOKLET IN ANY WAY. Write your answers in the appropriate column for answers against the relevant problem number.

3. Give only ONE ANSWER to each problem. If you wish to alter or amend your answer on the answer sheet, cross the one you have already put and write the new answer legibly.

4. If you find any problem too difficult, proceed to the next. Do not waste time on the difficult problems. You may return to the left out problems after finishing the test.

5. No questions about the test will be answered after the testing begins.

6. A few illustrations of the type of questions that you will find in the test are given on the next page.

INSTRUCTIONS & ILLUSTRATIONS

Example-1

Instruction: Find out the word which does not belong to the same class as the others.

Potato, Onion, Raddish, Ginger, Tomato

(a) Potato   (b) Onion   (c) Tomato   (d) Ginger

Solution: Out of the above mentioned vegetables, all except for tomato grows underground. Therefore, choice 'B' is the answer as tomato does not belong to the same class as the others. Choice 'c' is written against Example '1' on your answer sheet.

Example-2

Instruction: Two objects, events or concepts are related in same way. You have to establish the same relationship with the third and fourth object, event or concept on the basis of the alternatives given below each question.

Zoo : Animal :: Aquarium : ?

(a) Birds   (b) Fish   (c) Bees   (d) Butterflies

Solution: A zoo is a place where animals are kept and an aquarium is a place where live fish and other water creatures are kept. Therefore, choice 'b' is the correct answer and is written against Example '2' on your answer sheet.

Example-3

Instruction: If LUNCH is coded as 58 then DINNER would be coded as

(a) 46   (b) 66   (c) 62   (d) 64

Solution: Each alphabet starting from A is assigned a numerical value. For eg, A = 1; B = 2;
C = 3 and so on. Therefore, DINNER will be coded as follows – D = 4; I = 9; N = 14; N = 14;
E = 5 and R = 18 which when added gives the value of 64. Choice 'd' is the correct answer and is written against Example '3' on the answer sheet.

Example-4

Instruction: Arrange the following words as they appear in the dictionary.

(a) jewel   (b) jiggle   (c) jungle   (d) jelly

(a) acbd   (b) dabc   (c) dbac   (d) bdca

Solution: The sequence in which the words would appear in the dictionary would be jelly, jewel, jiggle and jungle. Therefore, choice 'b' is the correct answer and is written against Example '4' on the answer sheet.

Example-5

Instruction: Write the choice of the alphabets which will come next in the series.

rscdstdetuef........

(a) uv   (b) vw   (c) uw   (d) fg   (e) wv

Solution: There are two sequences being followed in the series. The first is 'rs' and the next sequence is 'cd'. If you split the series written above, it wuld look like this.

rs cd st de tu ef ....

To continue with the series the alphabet pair which should follow would be 'uv' which is written in choice 'a'. Therefore choice 'a' is the correct answer and is written against Example '5' on the answer sheet.

Example-6

Instruction: If the interchanges are made in signs and numbers, which one of the four equations would be correct?

Interchange: Sign + and ÷ and number 3 and 6.

(a) $3 + 6 \div 2 = 4$ (b) $6 + 3 \div 4 = 2.5$

(c) $6 \div 3 + 3 = 6$ (d) $3 + 6 \div 6 = 10$

Solution: By interchanging the signs + and ÷ and numbers 3 and 6, we get,

(e) $6 \div 3 + 2 = 4$ or $4 = 4$, which is true

(f) $3 \div 6 + 4 = 3.5$ or $3.5 = 2.5$, which is false

(g) $3 + 6 \div 3 = 5$ or $5 = 6$, which is false

(h) $6 \div 3 + 6 = 8$ or $8 = 10$, which is false

Therefore, choice 'a' is the correct answer and is written against Example '6' on the answer sheet.

Example-7

Instruction: A is taller than B but not as tall as C. C is taller than D. D is taller than A but not as tall as C.

Who is the tallest of them all?

(a) a   (b) b   (c) d   (d) c

Solution: The analysis of the above proposition reveals that C is the tallest. Therefore, choice 'd' is the correct answer and is written against Example '7' on the answer sheet.

You will get similar problems in the test. In all, there are 40 problems

to be solved in this test

DO NOT TURN OVER THE PAGE UNLESS ASKED TO DO SO

MENTAL ABILITY TEST - VERBAL

(1) **Instruction:** By using the sequence of the alphabets (A to Z), which letter would be the fifth
    letter after the letter, which comes midway between L and R:

      (a) P   (b) R   (c) Q   (d) S   (e) T

Instruction: Write the choice of the alphabet, which will come next in the series?

(2) qxapxboxc ...

      (a) nxc   (b) mcd   (c) nxd   (d) nxe   (e) mxd

(3) **Instruction:** Write the choice of the number which will replace the question marks
    in the following figure.
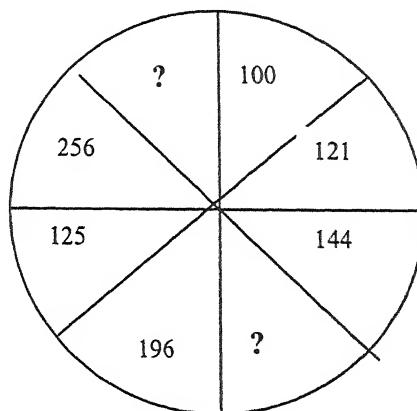
      (a) 159, 269   (b) 162, 289   (c) 169, 289   (d) 152, 356   (e) 166, 336

(4) **Instruction:** Write the choice of the number which will replace the question mark
    in the matrix.

4	9	16
25	?	49
64	?	100

      (a) 27, 71   (b) 36, 81   (c) 32, 79   (d) 34, 73   (e) 35, 75

Instruction: Write the choice of the alphabet, which will come next in the series?

(5) npaoqapraqsa…

    (a) rua   (b) sta   (c) rsa   (d) rta   (e) qra

(6) By using the sequence of the alphabets (A to Z), which letter would come just after the fifth letter after E.

    (a) H   (b) L   (c) I   (d) K   (e) J

(7) If "CERTAIN" is coded as "XVIGZRM" in a particular code language, then how would "MUNDANE" be coded in that language?

    (a) NFMWZMX   (b) VMZWMFN   (c) NFMWZMV   (d) MFMXZMV

Instruction: Write the choice of the alphabet which will come next in the series?

(8) aduacuaeuabuaf….

    (a) uaa   (b) uag   (c) afa   (d) ufa   (e) uac

(9) **Instruction:** By using the sequence of the alphabets (A to Z), which letter would come before the letter which comes before M..

    (a) K   (b) L   (c) M   (d) J   (e) I

(10) Find out the number which does not belong to the same class as the others.
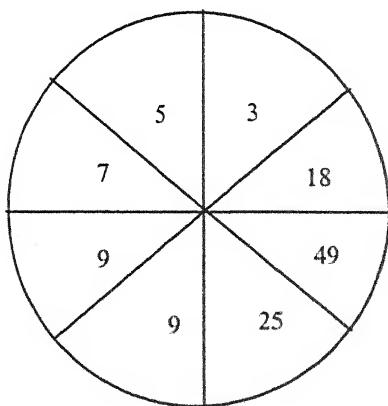
    (a) 36   (b) 18   (c) 16   (d) 9   (e) 49

(11) When 'FIRE' and 'WATER' are coded as 'SPGT' and 'BXETG', then what would be the code for 'EARTH'?

(f) TXGQR
(g) GETXQ
(h) EXTGQ
(i) TXGEQ

(12) By using the sequence of the alphabets (A to Z), the second letter before the sixth letter would be:

(a) C   (b) D   (c) E   (d) F   (e) B

(13) **Instruction:** Two objects or events are related in some way. You have to pick out only that option which has the same type of relationship as stated in each question from the alternatives given below each question.

Man : Child :: Flower : ?

(a) Bud   (b) Fruit   (c) Branch   (d) Plant

(14) If FATHER is coded as '612859' and 'MOTHER' is coded as '462859', code for 'UNCLE' and 'AUNT' would be _____ & _____.

(j) 35353 & 1253
(k) 33535 & 3125
(l) 53535 & 5123
(m) 35335 & 1352

(15) If 'KING' is coded as 'PRMT' and 'QUEEN' is coded as 'JFVVM', then 'PRINCE' will be coded as _____.

(n) KIRVMX
(o) KIRMVX
(p) KIRMXV
(q) KIMRVX

(16) Instruction: Two objects or events are related in some way. You have to pick out only that option which has the same type of relationship as stated in the question from the alternatives given below the question.

Atom : Molecule :: Element : ?

(a) Electron   (b) Mixture   (c) Isomer   (d) Isotope

(17) **Instruction:** Arrange the following words in the sequence that they would appear in the dictionary.

(i) Asthma (ii) Aeroplane (iii) Aesthetic (iv) Astronaut

(a) acdb (b) bcda (c) bcad (d) adbc (e) bdca

(18) **Instruction:** Many words can be produced from the given word. They are grouped into four clusters. One of the clusters contains a word that cannot be produced from the given word. Which is that cluster?
Given word: FRAGRANCE

(a) GRACE, FARE, RAN (b) FAR, RAGE, RARE

(c) FRANCE, GLANCE, CAR (d) ARE, CAN, RAG

(19) **Instruction**: If + means ×, - means + and × means ÷ find the value of

$5 + 4 - 18 \times 3 = ?$

(a) -34 (b) 6 (c) 26 (d) 15 (e) 14

(20) **Instruction:** Find out the word or number, which does not belong to the same class as the others.

Sparrow, Eagle, Crow, Ostrich, Kite

(a) Ostrich (b) Eagle (c) Kite (d) Sparrow

(21) **Instruction:** Use the sequence of the alphabets (A to Z). Suppose the first and second letters of the alphabet were interchanged, also the third and fourth, the fifth and sixth, and so on. Which letter would then be the 17th in the new sequence?

(a) Q (b) T (c) R (d) S (e) T

(22) **Instruction:** Write down the letters, which are in the same position to one another in the word 'ARCH' as they are in the alphabet.

(a) AC (b) AR (c) CH (d) RC (e) AH

(23) **Instruction:** Use the sequence of the alphabet (A to Z). Suppose the 3rd letter of the alphabet were crossed out, also the 6th, the 9th, the 12th, and so on. What would be the fifth letter not crossed out in the new sequence?

(a) H (b) G (c) J (d) D (e) B

(24) **Instruction:** If 'COLD' is coded as 'FSQT' then 'HEAT' will be coded as?

(a) KJFY (b) KIGZ (c) KIFZ (d) YIGY

(25) **Instruction:** Write the word pair, which does not belong to the same class as the others.

Lion and Den, Cow and Kennel, Pig and Pen, Hen and Farm, Horse and Stable

(a) Lion and Den   (b) Cow and Kennel

(c) Pig and Pen   (d) Hen and Farm

(26) **Instruction:** If 'CLAIM' is coded as 'DNDMR' then 'CHARGE' will be coded as?

(a) DJDVLK   (b) DJDWLL

(c) DJCVMK   (d) DIDWKL

(27) **Instruction:** If $\times$ means $\div$, $-$ means $\times$, $\div$ means $+$ and $+$ means $-$, then

$$(3 - 15 \div 19) \times 8 + 6 = ?$$

(a) 8   (b) 4

(c) 2   (d) -1   (e) None of these

(28) **Instruction:** By using the sequence of the alphabets (A to Z), which set of letters follow a specific sequence?

(a) AEIOU   (b) ACEGI   (c) ACJEI   (d) AEIMO   (e) AJKLT

(29) **Instruction:** If P denotes $\div$, Q denotes $\times$,R denotes +, and S denotes $-$ then

18 Q 12 P 4 R 5 S 6 = ?

(a) 36   (b) 53   (c) 34   (d) 65   (e) 59

(30) **Instruction:** Two objects, events or concepts are related in some way. You have to establish the same relationship with the third and the fourth object, event, or concept on the basis of the alternative given below the question.

Executive functions: President : : Legislative functions : ?

(a) Defence Minister   (b) Prime Minister

(c) Speaker   (d) Home Minister

(31) **Instruction:** If $+$ means $\div$, $\times$ means $-$, $\div$ means $\times$ and $-$ means $+$, then

$8 + 6 \times 4 \div 3 - 4 = ?$

(a) -12   (b) $-\dfrac{20}{3}$

(c) 12   (d) $\dfrac{20}{3}$ (e) None of these

(32) **Instruction:** Write the choice of the number which will replace the question mark in the matrix.

1	6	21
2	10	?
3	15	36

(a) 28   (b) 26   (c) 24   (d) 32   (e) 34

(33) **Instruction:** If $\times$ means $+$, $\div$ means $-$, $-$ means $\times$ and $+$ means $\div$,

$8 \times 7 - 8 + 40 \div 2 = ?$

(a) 1   (b) $7\dfrac{2}{5}$ (c) $8\dfrac{3}{5}$ (d) 44   (e) None of these

(34) **Instruction:** Rahul is five years old and Sohan is nine. In how many years will their ages when added make it 24?

(a) 7   (b) 6   (c) 5   (d) 8

(35) **Instruction:** When interchanges are made in signs and numbers, which one of the four equations would be correct?

Interchange
Signs $+$ and $\div$ and Number 2 and 4.

(a) $2 + 4 \div 3 = 3.0$ (b) $4 + 2 \div 6 = 1.5$

(c) $4 \div 2 + 3 = 4.0$ (d) $2 + 4 \div 6 = 8.0$

(36) **Instruction:** When interchanges are made in signs and numbers, which one of the four equations would be correct?

Interchange
Signs + and × and numbers 4 and 5

(a) $5 \times 4 + 20 = 40$

(b) $5 \times 4 + 20 = 85$

(c) $5 \times 4 + 20 = 104$

(d) $5 \times 4 \div 20 = 85$

(37) **Instruction:** When interchanges are made in signs and numbers, which one of the four equations would be correct?

Interchange
Signs – and × and Numbers 3 and 6

(a) $6 - 3 \times 2 = 9$

(b) $3 - 6 \times 8 = 10$

(c) $6 \times 3 - 4 = 15$

(d) $3 \times 6 - 4 = 33$

(38) **Instruction:** Rampur is located between Hamidnagar and Solan. Hamidnagar is located between Mohannagar and Solan. Therefore, which one of the following statements is correct?

(f) Rampur is not between Mohannagar and Solan.

(g) Rampur is between Hamidnagar and Mohannagar.

(h) Rampur is nearer to Hamidnagar than to Mohannagar.

(i) Rampur is nearer to Hamidnagar than to Solan.

(j) Solan is nearer to Hamidnagar than to Rampur.

(39) **Instruction:** When interchanges are made in signs and numbers, which one of the four equations would be correct?

Interchange
Signs – and ÷ and Numbers 4 and 8

(a) $6 - 8 \div 4 = -1.0$

(b) $8 - 6 \div 4 = 1.0$

(c) $4 \div 8 - 2 = 6.0$

(d) $4 - 8 \div 6 = 2.0$

(40) **Instruction:** Which one of the four interchanges in signs and number would make the given equation correct. $6 \times 4 + 2 = 16$

(a) $+$ and $\times$, 2 and 4

(b) $+$ and $\times$, 2 and 6

(c) $+$ and $\times$, 4 and 6

(d) None of the above

===== ****** =====

FINAL MENTAL ABILITY TEST
(NON-VERBAL)

MENTAL ABILITY TEST

INSTRUCTIONS:

1. This is a test of your ability to solve problems quickly and correctly. Try to do as many problems as possible. Do your best.

2. All your answers must be recorded on the answer sheet provided to you along with the booklet. DO NOT MARK THIS BOOKLET IN ANY WAY. Write your answers in the appropriate column for answers against the relevant problem number.

3. Give only ONE ANSWER to each problem. If you wish to alter or amend your answer on the answer sheet, cross the one you have already put and write the new answer legibly.

4. If you find any problem too difficult, proceed to the next. Do not waste time on the difficult problems. You may return to the left out problems after finishing the test.

5. No questions about the test will be answered after the testing begins.

6. A few illustrations of the type of questions that you will find in the test are given on the next page.

MENTAL ABILITY TEST

INSTRUCTIONS:

1.   This is a test of your ability to solve problems quickly and correctly. Try to do as many problems as possible. Do your best.

2.   All your answers must be recorded on the answer sheet provided to you along with the booklet. DO NOT MARK THIS BOOKLET IN ANY WAY. Write your answers in the appropriate column for answers against the relevant problem number.

3.   Give only ONE ANSWER to each problem. If you wish to alter or amend your answer on the answer sheet, cross the one you have already put and write the new answer legibly.

4.   If you find any problem too difficult, proceed to the next. Do not waste time on the difficult problems. You may return to the left out problems after finishing the test.

5.   No questions about the test will be answered after the testing begins.

6.   A few illustrations of the type of questions that you will find in the test are given on the next page.

EXAMPLE-1

Instruction: Out of the five figures A, B, C, D and E given below four figures are similar in one way. However, one figure is not like the other four. Choose the figure which is different from the rest.

Solution: Except in figure (A), in all other figures the two arrows point in different directions. The arrows in figure (A) point in the same direction and hence the figure (A) is different from the other four. Figure (A) is therefore the correct answer and is written against example '1' on your answer sheet.

EXAMPLE-2

Instruction: Write the correct choice of the figure which would be required to continue with the series.

Problem Figures   Answer Figures

Solution: In the problem figures, one petal gets added to the flower in a serial order starting from one petal in the 1st figure to five petals in the 5th figure. The figure that should continue the series, therefore, should have six petals. Choice (C) is the correct answer and is written against example '2' on your answer sheet.

EXAMPLE-3

Instruction: In this example, figure 'W' has some relationship with figure 'X'. Figure 'Y' has the same relationship with one of the five choice figures namely A, B, C, D & E. You are required to find out the correct answer and write the correct choice on the answer sheet.

Problem Set

F	⊐F	J	?
W	X	Y	Z

Answer Set

ττ	११	Jτ	τJ	τI
A	B	C	D	E

Solution: When one sees the problem figures one finds that figure X consists of the same figure as figure W and also its mirror image. Similarly, figure Y should be followed by a choice which has both the figure Y as well as its mirror image. Looking at the answer figures one sees that choice (C) fulfils the condition and hence choice (C) is the correct answer and is written against example '3' on your answer sheet.

EXAMPLE-4

Instruction: This part of test involves the problems relating to the counting of geometrical figures in a given complex figure. Study the geometrical figure carefully and write the choice of your answer in the answer sheet.

Example: How many number of straight lines are there in the following figure?

(A) 11 (C) 16
(B) 17 (D) 14

Solution: The figure is labeled as shown.
There are three horizontal lines namely AE, LF, & KG.
There are five vertical lines: AK, BJ, CI, DH and EG.
There are six slanting lines: LC, KE, IF, LI, AG and CF.
Thus there are 3+5+6=14 straight lines in the figure.
Therefore, choice (D) is the correct answer and is written against example '4' on your answer sheet.

EXAMPLE-5

Instructions: In each of the following questions, choose the correct mirror image of the figure X from amongst the four alternatives (A), (B), (C) and (D) given along with it.

(X) (A) (B) (C) (D)

Solution: In a mirror image the right side of the object appears on the left side and vice versa. The above figure (X) when seen in a mirror the half circle on top left corner will appear on top right corner and the triangle on bottom right will appear on bottom left. Therefore, choice (B) is the correct answer and is written against example '5' on the answer sheet.

EXAMPLE-6

Instruction: Write the choice of the correct figure which will complete the design shown in figure X.

X   A   B   C   D

Solution: The figure X has a part of the pattern which is missing. On closer look at the choice figures one sees that figure in choice (B) when added to the figure X would complete the figure. Hence, choice (B) is the correct answer and is written against example 6 on the answer sheet.

EXAMPLE-7

Instruction:: The problem figure, P, is hidden in one of the figures shown in the choice figures A, B, C & D. Find the figure (P) and write the correct choice on your answer sheet.

Solution: On closer look you will find that the figure (P) is hidden in choice (A) and cannot be identified in the other choice figures. Choice (A) is, therefore, the correct answer and is written against example 7 on your answer sheet.

You will get similar problems in the test. In all, there are 100 problems to be solved in this test.

DO NOT TURN OVER THE PAGE UNLESS ASKED TO DO SO

Instruction: The following question consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

| Problem Set	Answer Set

1.

W   X   Y   Z   A   B   C   D   E

Instruction: The following question consists of figures called problem figures which are followed by other figures called answer figures. Select the figures from amongst the answer figures which will continue the same series as established by the problem figures.

Problem Figures   Answer Figures

2.

1   2   3   4   A   B   C   D

Instruction: Write the choice of the correct figure which will complete the design.

3.

?

A   B   C   D

Instruction (for Q.Nos. 4 & 5): The following questions consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

4.

Problem Set				Answer Set				
W	X	Y	Z	A	B	C	D	E

5.

Problem Set				Answer Set				
W	X	Y	Z	A	B	C	D	E

Instruction (for Q.Nos. 6 & 7): The following questions consists of figures called problem figures which are followed by other figures called answer figures. Select the figure from amongst

6.

Problem Figures					Answer Figures				
1	2	3	4	5	A	B	C	D	E

7.

Problem Figures				Answer Figures			
1	2	3	4	A	B	C	D

Instruction: The following question consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

8.

Problem Set				Answer Set				
W	X	Y	Z	A	B	C	D	E

9.
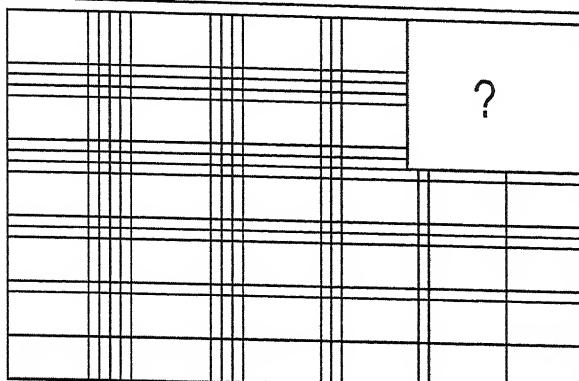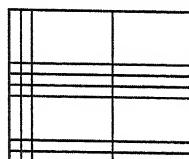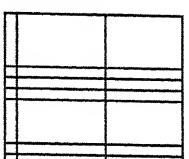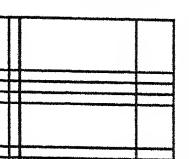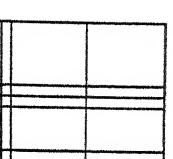
A   B   C   D

Instruction: In the following question, choose the correct mirror image of the figure X from amongst the four alternatives (A), (B), (C) and (D) given alongwith it.

10.
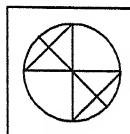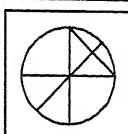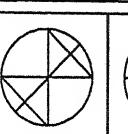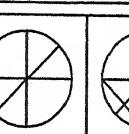
X   A   B   C   D

11.
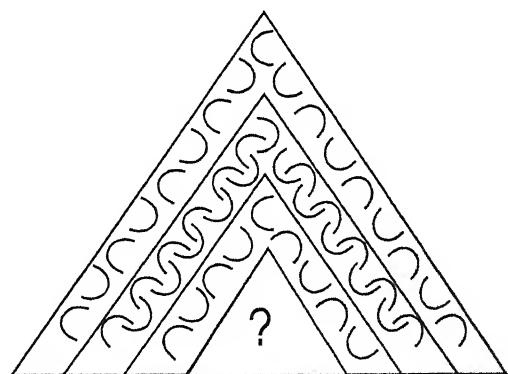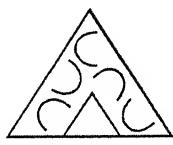
A   B   C   D
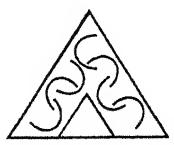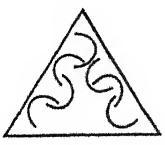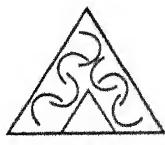
Instruction: The following question consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

Problem Set	Answer Set

12.

W	X	Y	Z

A	B	C	D	E
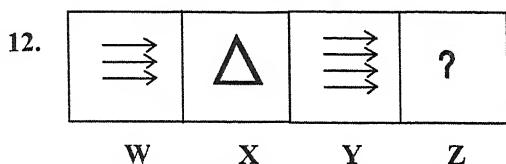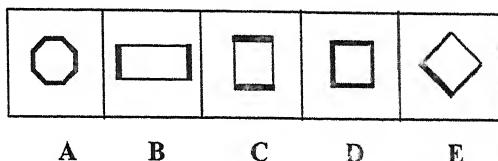
Instruction (for Q.Nos. 13 & 14): The following questions consists of figures called problem figures which are followed by other figures called answer figures. Select the figure from amongst the answer figures which will continue the same series as established by the problem figures.

Problem Figures   Answer Figures

13.

1   2   3   4

A   B   C   D

Problem Figures   Answer Figures

14.

1   2   3   4

A   B   C   D
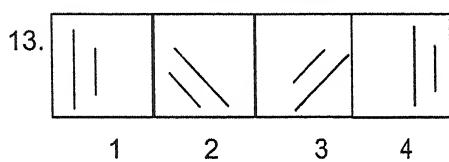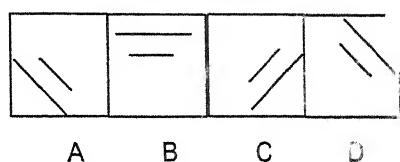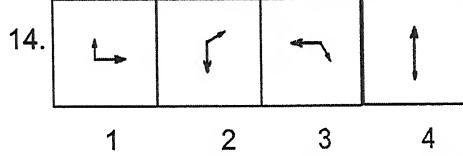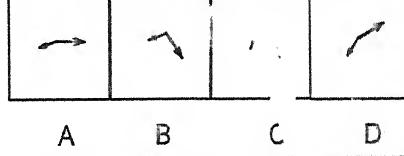
Instruction (for Q.Nos 15 & 16): The problem figure, P, is hidden in one of the figures shown in the choice figures A, B, C and D. Find that figure (P) and write the correct choice on your answer sheet.

15.

P

A   B   C   D

16.

P

A   B   C   D

235

Instruction: The following question consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

Problem Set	Answer Set

17.

W   X   Y   Z   A   B   C   D   E

Instruction: Write the choice of the correct figure which will complete the design.

18.

A   B   C   D

Instruction: In the following question, choose the correct mirror image of the figure X from amongst the four alternatives (A), (B), (C) and (D) given alongwith it.

19.

X   A   B   C   D

236

20.

A   B   C   D

Instruction (for Q.Nos 21 & 23): In the following questions, choose the correct mirror image of the figure X from amongst the four alternatives (A), (B), (C) and (D) given alongwith it.

21.
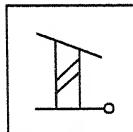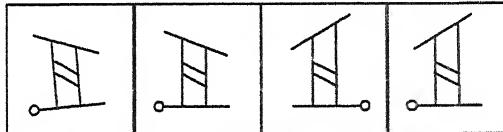
X   A   B   C   D

Instruction: The problem figure, P, is hidden in one of the figure shown in the choice figures A, B, C and D. Find that figure (P) and write the correct choice on your answer sheet.

22.
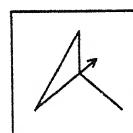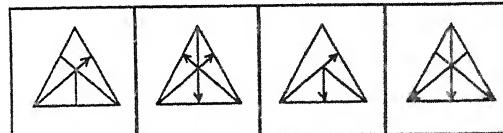
P   A   B   C   D

23.
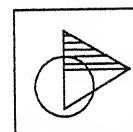
X   A   B   C   D
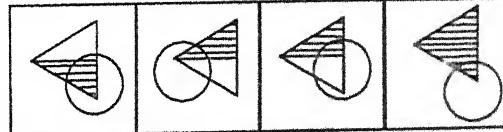
Instruction(for Q.Nos 24 & 25): The following questions consists f two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

Problem Set	Answer Set

24.

W	X	Y	Z		A	B	C	D	E

Problem Set	Answer Set

25.

W	X	Y	Z		A	B	C	D	E
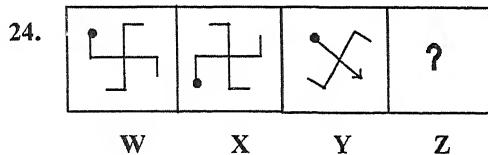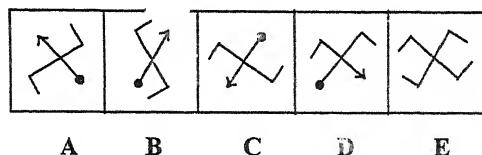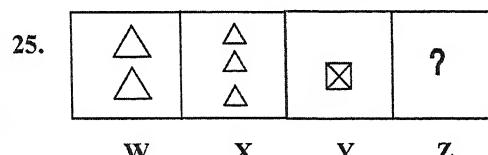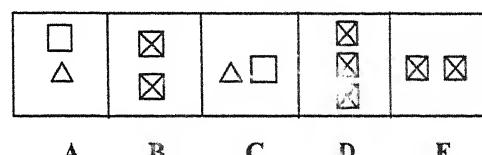
Instruction(for Q.Nos 26 & 27): The problem figure, P, is hidden in one of the figures shown in the choice figures A, B, C and D. Find that figure (P) and write the correct choice on your answer sheet.

26.

P   A   B   C   D

27.

P   A   B   C   D

Instruction: The following question consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

Problem Set	Answer Set

28.

W	X	Y	Z		A	B	C	D	E

238
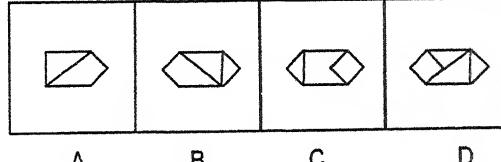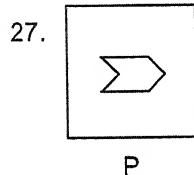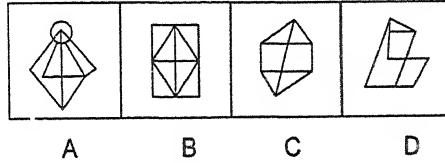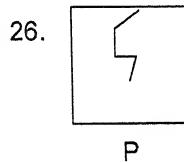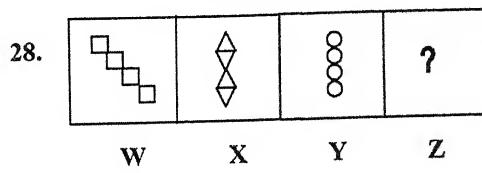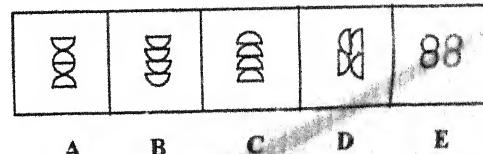
Instruction (for Q.Nos 29 & 30): Write the choice of the correct figure which will complete the design.

29.

A   B   C   D

30.

A   B   C   D

Instruction: The following question consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

Problem Set	Answer Set

31.

W	X	Y	Z

A	B	C	D	E

Instruction: Write the choice of the correct figure which will complete the design.

32.

A	B	C	D

Instruction: The following question consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

Problem Set	Answer Set

33.

W	X	Y	Z

A	B	C	D	E

Study the following figure and answer question number 34.
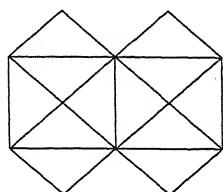
34. Count the number of squares in the figure.

(A) 5   (B) 6   (C) 7   (D) 8   (E) 9

Instruction (for Q.Nos 35 & 36): Out of the five figures (A), (B), (C), (D) and (E) given in each problem four are similar in one way. However, one figure is not like the other four. Choose the figure which is different from the rest.

35.

A   B   C   D   E

36.

A   B   C   D   E

Instruction: The following question consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

| | Problem Set | | | Answer Set | | | | |

37.

W   X   Y   Z   A   B   C   D   E

Instruction: Out of the five figures (A), (B), (C)) and (E) given in each problem four are similar in one way. However, one figure is not like the other four. Choose the figure which is different from the rest.

38.

A   B   C   D   E

Instruction: The following question consists of two sets of figures. Figure W, X, Y and Z constitute the problem set while figures A, B, C, D and E constitute the answer set. There is a definite relationship between figure W and X. Establish a similar relationship between figures Y and Z by choosing a suitable figure (Z) from the answer set.

Problem Set   Answer Set

39.

W   X   Y   Z   A   B   C   D   E

Instruction: Write the choice of the correct figure which will complete the design.

40.
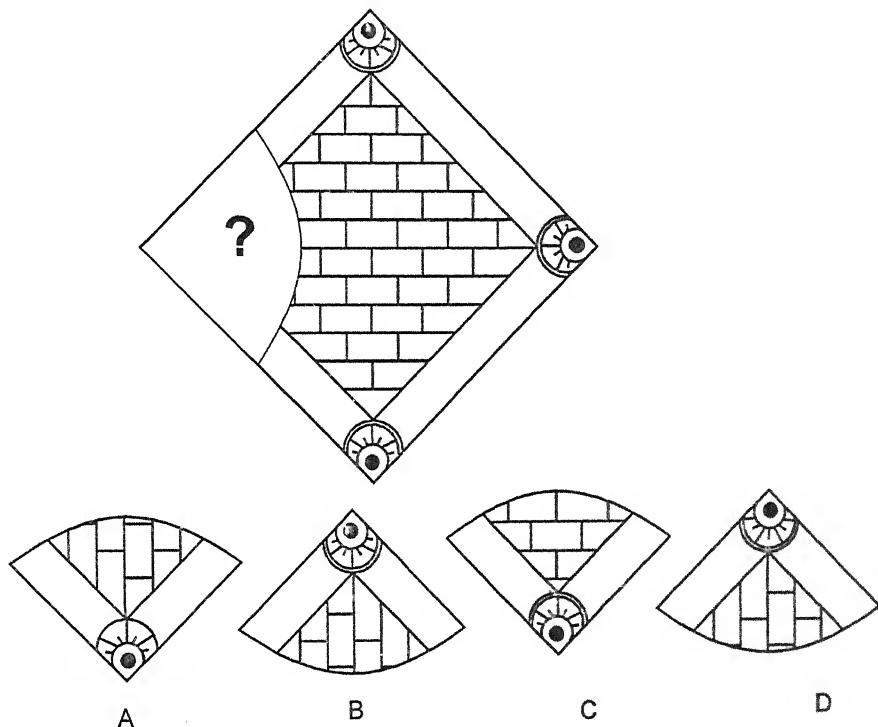
A   B   C   D

====***====

Raw Scores and Standard (Converted) scores of Verbal Mental Ability Tests

Raw Score	Z Score
0	22
1	24
2	25
3	27
4	28
5	30
6	31
7	32
8	34
9	35
10	37
11	38
12	39
13	41
14	42
15	44
16	45
17	47
18	48
19	49
20	51
21	52
22	54
23	55
24	57
25	58
26	59
27	61
28	62
29	64
30	65
31	67
32	68
33	69
34	71
35	72
36	74
37	75
38	77
39	78
40	79

Raw Scores and Standard (Corrected) Scores of Non-Verbal Mental Ability Tests

Raw Score	Z Score
0	20
1	22
2	23
3	25
4	26
5	28
6	29
7	30
8	32
9	33
10	35
11	36
12	38
13	39
14	41
15	42
16	44
17	45
18	47
19	48
20	50
21	51
22	53
23	54
24	56
25	57
26	59
27	60
28	62
29	63
30	65
31	66
32	68
33	69
34	71
35	72
36	74
37	75
38	77
39	78
40	80

Norms for Verbal and Non-Verbal Mental Ability Test

Scores	Description of Mental Ability
127 & above	Well-above average
108-126	above average
88-107	average
66-87	below average
65 and below	Well-below average